AN EVALUATION OF SCHOLARLY WORK AT THE UNIVERSITY OF ICELAND

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A study carried out for the Ministry of Education, Science and Culture in Iceland

August 2005

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INTRODUCTION

The origins of the study

This evaluation of the University of Iceland's performance as a research university is carried out at the request of the Ministry of Education, Science and Culture.[1] The Universities Act of 1998 emphasizes increasing autonomy of Iceland's higher education institutions in managing financial and human resources. At the same time the Act emphasizes the monitoring role of the Ministry in assuring quality of research, teaching and administration. To implement its new responsibilities, the Ministry issued regulations on quality control in higher education in 1999. The current evaluation is one component of its multi-part monitoring of compliance with this regulation.

The evaluation focuses on the research mission of the University of Iceland. It assesses the contribution of scholars at the University of Iceland to local (Icelandic) and international knowledge. It also examines links between the University of Iceland and Icelandic society, as well as the links between the University of Iceland and the international scientific community.

Iceland's recent linkage between providing its higher education institutions with increased autonomy from government regulations and yet requiring increased accountability and documentation are developments found widely across the higher education systems of many European and other industrialized economies. A shared view among elected officials, service delivery organizations, industrial leaders and representatives from the higher education community is that a nation's ability to generate and assimilate scientific and technological knowledge is increasingly essential for improving national well-being, broadly defined here to include sustained economic growth and improved quality of life. A nation's ability to generate new scientific knowledge is seen as essential both to the launching of new industries and to the continuing vitality and international competitiveness of traditional economic sectors. Moreover, an ability to generate new scientific knowledge, even if not necessarily on the scale of larger or more research-intensive nations, is seen as an indispensable requirement for an ability to assimilate and adapt scientific and technological advances developed elsewhere.

Evaluation of research

Iceland's recent policies of providing its higher education institutions with increased autonomy from government regulations and yet requiring increased accountability and documentation are developments found widely across the higher

[1] The full terms of reference for the study are provided in Appendix I.

education systems of many European and other industrialized economies. This heightened interest in the potential contributions of scientific and technological knowledge to national objectives underlies the policy and organizational ferment now evident across most of Europe, Japan and other countries. It is not a blank check, however. In return for liberalization of rules governing the performance of scientific work and, in many countries, increased funding, whether in public universities or government laboratories and institutes, the scientific community is expected and indeed required to document the success and significance of its work.

These same trends shape the new environment in which the University of Iceland performs research. The university is a publicly funded university with about two-thirds of its funding from government. As with other functional sectors such as health and the environment and with other organizations such as institutions and areas funded by public money, the university too faces increased demands for evidence of efficiency and success.

Evaluation however is something more than an audit activity. By providing documented evidence of inputs, activities and outcomes, evaluation can contribute to making the performance and impact of an organization more visible to governmental bodies, university administrators, faculty, students and other stakeholders, such as private industry. In addition, as a "formative" activity, designed to call attention to both satisfactory and less than satisfactory areas of performance, evaluation may serve to guide corrective action. Undertaken at the specific direction of the Ministry, the evaluation also serves the overlapping and reinforcing interests of Iceland's Science and Technology Policy Council and the University of Iceland. Independently, each has called for more systematic inquiry into how well the University is performing its research mission. The Science and Technology Policy Council has, for example, set forth two overarching objectives for its activities:

- to increase appropriations to scientific and technological activities, and
- to increase the quality and results of scientific work.

This evaluation contributes to achieving the second objective and will consider the quality of research as well as the operational context and funding mechanisms which support research.

The University of Iceland also has recently articulated a strengthened commitment to research, setting for itself the objective of becoming an internationally recognized performer of research in selected areas of emphasis and of increasing the contribution of its research to an understanding of Iceland's distinctive history, society, and culture.[2] In order to contextualize this evaluation we will introduce some general issues in

[2] See the University of Iceland Act no. 41, 22 March 1999; Rules for the University of Iceland, no. 458/2000; University of Iceland Aims and Measures 2003-2005.

university research at this point and invite the reader to keep them in mind while reading the evaluation.

Issues in university research

> Whereas science traditionally has been regarded as an inner directed, intellectually self-propelled enterprise that has 'spoken' to society, it now increasingly finds itself integrated in society, embedded in a context that increasingly 'speaks back' to science. The process whereby this happens is extremely complex, as are its implications.[3]

In this report we will be considering some of the issues which confront university research at the University of Iceland. We will be presenting data on the contribution of researchers at the university to scientific knowledge. We will also consider the way in which research is being funded and managed at the university. There are several common threads to such discussions about research in universities – knowledge, quality and autonomy – that arise persistently. Questions include:

- What knowledge is important, and to whom?
- How can the quality of research be ensured?
- What is a desirable level of autonomy in the conduct and administration of research?

There have been two major players in research in Iceland – the state universities, especially the University of Iceland, and the national research institutes, many of which were established after the Second World War. Issues which are being addressed in current policy documents and funding possibilities are the strengthening of these two players and increased cooperation between them.[4] There is also a certain tension between the two precisely because of their legal responsibilities and internal or external funding for their activities.

In the work of universities knowledge is understood to have taken on new meanings, increasing numbers of students attend university, a class of middle managers has appeared and issues of *quality*, *autonomy* and *accountability* have entered the research debate. These are issues with which the University of Iceland must grapple as it reviews its research policy. These are also issues which the Ministry of Education, Science and Culture must confront as they clarify and develop their policies on university research in Iceland.

There are essentially three levels of activity in university research – the state in relation to the university, the university as an institution and the individual working within the university.

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[3] Bleiklie, I. and Byrkjeflot, H. 2002, p. 523. Changing knowledge regimes: Universities in a new research environment. *Higher Education, 44*, 519-532.

[4] Science and Technology Council, 2003.

The last 15 to 20 years have seen sweeping changes in higher education in most of the OECD countries as they have tried to come to grips with changes in the needs of society. Most states have tried to develop a system such that control and responsibility reside with individual organizations. Accountability however has accompanied devolution and the way in which accountability systems are conceived and implemented give rise to tensions between the state and the institution, and within institutions.

Knowledge and knowledge production is no longer the exclusive property of an academic elite. Worldwide the numbers of those attending university have risen sharply over the last 10 to 20 years and knowledge and research are consequently less associated with elevated social status. This in turn means there is a better informed public with experience of a university life which goes to the polls and wants to know how their tax-money is being spent. Iceland and the University of Iceland are no exception to this pattern. The number of university students has doubled in the last decade or so.

As universities in Iceland have multiplied in number and increased in size, issues of conformity or diversity within or between institutions have arisen. In recent years the University of Iceland has come under pressure with the establishment of several new institutions of higher education, most of which are determined to develop their research capacity. Globalization and internationalization have also had their part to play in views on universities. National culture and identity no longer confer legitimacy, almost automatically, on a university run by the state. Byrkjeflot, 2001 points out however:

> [The national system] still sets the conditions for what kinds of received knowledge shall be taken for granted and passed on to new generations, and for the norms that regulate career advancement and elite selection.[5]

There are strong elements of quality control and accountability in the teaching and research agreements between the University of Iceland and the government. It is expected that the university will improve reporting measures about teaching and

[5] Quoted in Bleiklie, I. and Byrkjeflot, H. 2002, p. 523. Changing knowledge regimes: Universities in a new research environment. *Higher Education, 44*, 519-532.

research activities and that the university will find ways of rewarding the performance of individuals and departments. Performance incentives at an individual level have been in place for some time through the productivity fund and the central administration has now begun to assign part of departmental funding according to the productivity of departments.

Another of the issues being faced by universities is the extent to which teaching and research interact with one another. Teichler (2003) has pointed out that conflicts between research and teaching duties can lead to diverse responses.[6] Relevance of teaching and research is differently interpreted and absorbed by individual universities. Massification may lead to more time being spent on teaching, but research is rewarded more. The interaction between teaching and research may be stronger at institutional level than at an individual level. The possible interactions become particularly important when university funding in Iceland is largely dependent on the number of students enrolled.

When all is said and done, what may matter the most for success in research is the quality of the staff employed by a university.[7] Liefner found that the link between performance-based research allocation and the success of universities was weak. Over 90% of interviewees in six top research universities stressed that the quality of academics was far more important for success than other factors such as student ability, university culture, and form of resource allocation or other incentives. There are many ways to employ and motivate individuals. It will be seen from the research performance data that there are many highly qualified individuals employed by the University of Iceland. The difficulty at every level, from individual to course, to department to field, will be to find ways of employing the best research staff and motivating a variety of temperaments in order to produce the best research. At the same time due attention must be paid to the other functions of the university, namely teaching and service to society.

In summary, the University of Iceland, like its sister institutions across much of Europe, has been responding in recent decades to the multiple but not always consistent pressures arising from governments, emerging economic sectors, citizens, students, and their own faculty and administrators. Its task is to simultaneously provide higher quality scientific and technical educations to an increasing percentage of the nation's population (massification), to increase their contribution to national objectives (relevance), become more efficient (reengineering) and to be more internationally competitive in the performance of research (benchmarking).

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[6] Teichler, Ulrich (2003). The future of higher education and the future of higher education research. *Tertiary Education and Management, 9*, 171-185.

[7] Liefner, I. (2003). Funding, resource allocation, and performance in higher education systems. *Higher Education*, 46, 469-489.

Structure of the report

The report is organized into seven chapters. The next chapter outlines the methodology used in the assessment. Chapter 3 presents an overview of the development that has taken place in research and university-related issues in Europe in recent years. The fourth chapter describes the legal framework within which the University of Iceland operates the governmental and collective bargaining rules that apply to research conducted at the school and the University's self-determined policies regarding research work. Also described is the University's internal system of research evaluation. External and internal rules are presented as providing a set of constraints and incentives for research. Chapter 5 provides empirical analysis of the University's research performance, measured both in terms of domestic trends and international standing. Chapter 6 presents a brief overview of funding mechanisms for research. Chapter 7 presents conclusions and recommendations.

METHODOLOGY

Nations differ in the organization of their national scientific, technological and innovation systems. They differ in emphasis placed on functional areas such as economic development, health, energy, cultural preservation; on generic types of research such as basic, applied or development; on organizational configurations such as universities, government mission-oriented laboratories, and independent research institutes; and on the mechanisms for funding these organizations such as line item budgets; competitive awards or a combination. Reflecting this diversity, an extensive and diverse set of methods has been developed to evaluate the performance of research organizations.

Common though across national settings to the evaluation of the research performance of universities has been the use of bibliometrics, either singly or in combination with other methodologies. The two principal measures used, with variations, have been the quantity of published research (in the case of journals, weighted by quality measures), and the number of references (citations) made to these works (at times also weighted by quality of journals).

The roots of these methods of evaluation can be traced to the traditions and norms of the scientific community and to the prevailing notions on the role of scholars; that scholarly knowledge should always be made public and that the core of research work entails publishing results in acknowledged academic publications. These norms serve multiple purposes. The requirement that work be made public provides opportunities for other researchers to assess the accuracy of a researcher's claims. Publication also serves to establish priority in claims for originality and importance. Citations in turn serve as a proxy for the larger community's assessment of the importance of any single piece of research. Thus one of the most important functions of university faculty is to publish findings that are subject to the rigorous assessment by the qualified peers.

Over the past few years, significant changes have occurred within the scientific community as regards the role of university scholars. New roles, such as disseminating information to companies, institutions and to the general public, holding seats in the management committees of companies due to scientific knowledge, applying for research funds, managing large research groups and institutions, organizing conferences, chairing scientific committees, allocating funds from research trusts and training young scientists are now all important parts of the role of the scholars. As a result of these changes, a number of scholars have argued for the importance of using more than two indicators in the assessment of scholarly work.[8]

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[8] Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., and Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage Publications.

The evaluation of scholarly work needs to reflect the roles of scholars, research institutes and universities as they are at a given period. In that way, it may be possible, not only for faculty at universities, but for all parties concerned with any given research project to assess the competence of scholars and the quality of their work. Accordingly, this evaluation employs multiple methods. As described in the sections below, it uses a mix of interviews, bibliometric analysis and surveys.

Quantitative indicators

Several types of quantitative bibliometric data are used in the study. At the macro or national level, it employs aggregate publication statistics data from he National Science Indicators (NSI) database. NSI is published by the *Institute for Scientific Information (ISI)*, in Philadelphia, USA, which also publishes the *Science Citation Index (SCI*), the *Social Science Citation Index (SSCI)*, and the *Arts & Humanities Citation Index (AHCI)*, as well as several other bibliometric products on scientific publishing.

The second type of bibliometric data used is micro data. The University of Iceland gathers extensive data from faculty about their scholarly activities, including numbers of articles by academic staff in international academic journals (in SCI, SSCI and AHCI), the number of articles by them in other journals (i.e. not in the three former mentioned databases), the number of lectures, i.e. conference presentations, plenum and keynote lectures and editorship of journals. These data served as a foundation for a database created by the research team. The use of this data gives an opportunity to look at several different aspects of performance, and hence gives a broad view of the influence exerted by the University on the local as well as the international scientific community. A list of criteria appears in Appendix II.

The database includes information on research activities of all academic staff at the University in years 1999, 2000, 2001 and 2002. In aggregate form, the data was used to assess research performance among professors, associate professors and assistant professors. The study was confined to full-time faculty with teaching and research responsibilities during the four year period under study.[9] In total, data was collected on 278 academic staff, 148 professors (133 men and 15 women) and 130 associate and assistant professors (76 men and 54 women). From the total academic staff data was collected from 64 in the field of Social Science, 68 in the field of Humanities, 60 in the field of Health Science and 86 in the field of Science and Engineering.

Nowotny, H., Scott, P., and M. Gibbons (2001). *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*, Blackwell Publishers Inc. Malden, MA.

[9] An exception was made withing the Health Sciences sector where the group also includes professors working half time. The exception was made since only a small proportion of professors within that sector works as full time teachers and researchers.

Third, bibliometric information on collaboration between scholars was gathered from the Web of Science, which lists articles published in ISI journals (see above). Bibliometrically, international collaboration is measured using co-authorship data. It is assumed that if a paper is written by more than one author, the underlying research was carried out in collaboration between those authors and thus the institutions at which they work. International collaboration is assumed when a paper is written by authors from more then one country. This indicator is frequently used for the analysis of research collaboration. It should, however, be taken into consideration that, as Katz and Martin put it, it is by no means perfect.[10] Co-authorship should be seen as a partial indicator because only those collaborations which eventually lead to a joint publication are taken into account. Not all collaborations, however, result in publications and, conversely, a joint paper does not always mean that the results presented are based on direct research collaboration; sometimes academics find that papers can be written together after the research is completed.

Other quantitative data include a web survey of the views of faculty at the University of Iceland, in order to obtain information on other issues than those provided by the databases listed above. Response rate in the web survey among professors, associate professors and assistant professors was 78% in the field of Social Science, 61% in the field of Humanities, 45% in the field of Science and Engineering and 36% among faculty in the field of Health Sciences. Due to the low response rate in the field of Science and Engineering and in the field of Health Sciences only information from the fields of Humanities and Social Science was used in the assessment (the response rate within the two fields was 70%).

Qualitative indicators

In terms of qualitative information interviews were conducted with faculty and staff at the University of Iceland, as well as with faculty and staff at other universities and Icelandic institutions. The use of qualitative methods enables a deeper understanding of issues that may be difficult to study with quantitative methods. The analysis of data depends more on induction and the intuition and understanding of the researcher. The results are thus related to the researcher's understanding of the perceptions and experiences of the informants.[11] Interviews are considered to be a qualitative research tool. Semi-structured interviews focus on a particular topic e.g. research activities over a certain period. The interviewee (informant) decides on the pace of the interview, despite the structure, since the purpose is to extract the informant's point of view on the subject.

[10] Katz, J.S., and Martin, B.R. (1997). What is research collaboration? Research Policy, 26 (1): 1-18.
[11] Taylor, S. J. and Bogdan, R. (1984). *Introduction to qualitative research methods: The search for meaning*. New York, NY: John Wilay and Sons.

All 23 interviews were conducted in the spring, summer and fall of 2004. The lengths of the interviews were from 45 to 60 minutes. All the interviews were taped and transcribed. Some researchers were interviewed a second time. Fifteen interviews were conducted with faculty and staff at the University of Iceland, one interview was conducted with faculty at a university in Scandinavia and two with faculty at a university in the US. Also, five interviews were conducted with staff at the Ministry of Education, at the Ministry of Finance and at the Icelandic Center for Research (Rannis).

The data was analyzed as the interviews proceeded. Themes were found which were confirmed or considered more closely in new interviews. Finally the transcripts were read again to assess the experiences of the informants. The interviews were usually taken in the office of the informant or at the office of the team leader. Interviews with the Scandinavian researcher was conducted in Iceland and interviews with American researchers were conducted in the US.

THE DEVELOPING RESEARCH UNIVERSITY

The University of Iceland has committed itself to strengthening its performance and international standing in research, reflecting Iceland's new national commitment to science and technology, the influence of competitive steps taken by a number of comparable small nations (e.g., Ireland) to improve the research performance of national universities, and its own recent strides towards developing a broader and deeper research expertise[12]. Each of these imperatives continues to shape the objectives of the University of Iceland.

In interviews conducted in connection with this evaluation, faculty at the University of Iceland share this heightened commitment to research and it enjoys widespread support among university faculty. Like their counterparts in other European institutions, University of Iceland faculty view research as intrinsic to good teaching. Research also is seen as an important input into national objectives in economic competitiveness and national well-being. For Iceland to achieve these objectives there is a need in the view of faculty to enhance capabilities to utilize both home-grown and internationally produced knowledge.

University developments in Europe

In general, there has been a transformation in the image and roles of universities in the last two decades. The options in university education have widened from the liberal education supplied to an elite leadership to the acquisition of the specific skills and knowledge required in technologically advanced societies. At the same time the number of university students in Europe has more than doubled in the last twenty years[13]. National universities now carry out a complex task of *teaching* universal knowledge, *advancing* knowledge as well as *diffusing* and *extending* it to society. "Services to society" are by some scholars now included as the third core activity of universities.

The growing significance of science[14] and innovation has resulted in increased interest in the organization of scientific endeavors and the work of scientists and scholars at universities. Various parties outside the scientific community are interested in influencing choice of projects, often with a view towards channeling the efforts of faculty to more practical projects. In most cases, these new demands are made by parties outside the scientific community, such as politicians, directors of companies, officials and business entrepreneurs.

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[12] The University of Iceland Act no. 41, 22 March 1999; Rules for the University of Iceland, no. 458/2000; University of Iceland Aims and Measures 2002-2005.

[13] Eurydice (2000). Two Decades of Reform in Higher Education in Europe: 1980 onwards, Eurydice Studies, European Commission.

[14] The terms *science* and *research* are used interchangeably in this report.

Researchers are accountable in different ways. In Europe, increasingly academic institutions are now judged by the research output of their faculty and faculty members are hired and promoted primarily on the basis of their own research output. The Rector of the University of Bergen describes this trend in Norway in the following way:

> Today, when hiring faculty, the criteria are almost exclusively research based. Whatever merit you may have on the education side, doesn't really count. In Health Sciences and Natural sciences, they will also look at research organization. For example, has this person been able to gather a good research group? Has he or she headed it in a good way? In the Humanities and Social Sciences however, most research is still done on an individual bases, or in very, very small groups. There is also in general more emphasis on publications in good journals. In math, natural science and medicine there has for a long time been an emphasis on publishing as much as possible in the good international journals, while that has not been an explicit faculty policy in the Humanities and Social Sciences. That is going to change, because that is going to pay literally.

Indeed, of all the functions of universities, it is their role in research that today receives the greatest emphasis by governments in almost all OECD countries.[15] In line with this development, recent resolutions of the OECD Ministerial Council underline how education, research, innovation and entrepreneurship are viewed as the driving power for economic growth in modern societies.[16] As an example of that, the share of science-based products in total world trade more than doubled between 1970 and 1995, largely at the expense of agriculture and raw materials.[17] Investing in people is now viewed as a crucial issue for Europe's future and researchers are seen as forming a key element of the modern knowledge-based economy. Member states are encouraged to increase their support for science and research, creating favorable conditions for innovation based on new knowledge.

University operations

The changing social and financial context surrounding higher education has required a change in the operation of all aspects of university research. New sources of funding and funding mechanisms have evolved, often linked to particular "University models". These models highlight general and observable tendencies within the academic world[18]:

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[15] Nowotny H., Scott, P., and Gibbons, M. (2001). *Re-thinking Science: Knowledge and the Public in an Age of Uncertainty*. Cambridge: Polity Press.
[16] OECD, *Science and Technology Policy* (2003).
[17] Fagerberg, J.; Guerrieri, P., and Verspagen, B., ed. (1999). The Economic Challenge for Europe: Adapting to Innovation-Based Growth. Aldershot, UK: Edward Elgar.
[18] A Comparative International Assessment of the Organisation, Management and Funding of University Research in Ireland and Europe, report of the CIRCA Group Europe for the higher Educaion Authority, 1996.

- The collegial model, seeing the university as a self-governing community with consensual decision making.
- The bureaucratic model, professionally managed, often with close links to government.
- The market model, with the exchange of education and research for resources from society.

Over the last few decades the attention of the Icelandic government has turned increasingly to the bureaucratic/professional and market models as possibly the more effective in attaining economic and social goals, as well as being more open to accountability and to examination of internal efficiency. The university finds itself needing more middle managers as research grows, but faculty may be more accustomed to the collegial model.

While the importance of research as intrinsic to good teaching and a base for knowledge production has been growing in Europe in the last few years, concerns have been raised as to what role universities play in the European knowledge society and scholars have argued that Europe's universities may not be responding to the challenges facing higher education in the 21st century.[19] Difference in output by European and American scholars have raised questions as to whether something is wrong with European university-based research. Papers by American scholars are cited more often then papers by their European colleagues. Similarly, during the past decade more Nobel Prizes have been awarded to scientists working within the US system and they have outperformed European scholars on innovation.[20]

An explanation for this has been sought in the profoundly different funding systems and university culture within the EU and the US. In the United States, research universities conduct about half of the basic research,[21] of which the major research universities carry out a large proportion. In the US it is apparent that the most prestigious institutions of higher learning are almost invariably institutions which stress forefront research.

> Reputation is all important to academic intuitions in the US because there is such strong competition for both outstanding faculty and outstanding students. The subject is extremely complex, but the outcome seems clear, _ the majority of academic institutions are judged mainly by the research output of their faculty and the

[19] The Europe of Knowledge 2020: *A vision for university-based research and innovation.* Conference proceeding, Liége, Belgium, 25-28 april 2004.
[20] Science and Engineering Indicators, 2004. Vol. 1, National Science Foundation.
[21] Geiger, R.L. (1993). *Research and Relevant Knowledge:* American Research Universities Since World War II.

> institutions which do well in research are able to attract both students and faculty who can continue to do research at a very high level[22].

In order to increase the international competitiveness of the European system of higher education and to make sure that higher education in Europe acquires a world-wide degree of attraction, several European countries now participate in the Bologna process.[23] The main goal of the process is to achieve greater compatibility and comparability of the higher education systems in Europe by adopting a common framework of comparable degrees, by introducing undergraduate and post-graduate levels in all countries with first degrees no shorter than three years, by using comparable criteria and methods in quality assurance and by eliminating any remaining obstacles to the free mobility of students and teachers, researchers and higher education administrators. The rector of the University of Bergen describes one of the main aims of the Bologna process in the following way:

> The goal is not to make all European education similar, but to try to compete with higher education in the United States. The other main aim is to make it easier for students to move from one institute to the other. Also related to both of this is the notion of quality control or assessment. A part of the mandate is to get that more systematized. These aims provide the background for the process.

The European Union has in the last few years emphasized the establishment of a European Research Area (ERA), in which restrictions on mobility between countries and institutions are minimized. Under the Sixth Research Framework ERA networks are being established to facilitate the exchange of research results among national research programs. Networks of Excellence and Integrated Research Projects are also being used as specific instruments to encourage collaboration among key research teams. In some European countries university faculty are actively supported by their institutions in applications for such projects.

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[22] Richard E. Taylor, professor at Stanford University and Nobel Prize winner in Physics in 1990. Cited in: A Comparative International Assessment of the Organisation, Management and Funding of University Research in Ireland and Europe, report of the CIRCA Group Europe for the higher Educaion Authority, 1996.

[23] Joint declaration of the European Minsters of Education convened in Bologna on the 19th of June 1999: http://www.cepes.ro/information_services/sources/on_line/bologna.htm
The Bologna declaration was signed by Ministers of Education from Austria, Belgium (French community), Belgium (Flemish community), Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Swiss Confederation and the United Kingdom.

Changes affecting individual scholars

In general, scholars agree that the past two decades have been an extraordinary era in the sense of rapid accumulation of knowledge, coupled with considerable organizational change. Significant changes have occurred within the scientific community as regards the role of university scholars over the past few years.[24] On a growing scale, university work is characterized by organized cooperation between research institutes and universities with companies. Again, the rapid accumulation of knowledge means individuals can only claim a small fraction of the research as theirs, even in their own fields. Thus, it is often necessary to assemble a group of scientists to solve in unison common scholarly issues that require different abilities and knowledge of disparate academic fields. Again, the collective financing of projects requires new talents of university faculty. Last but not the least, globalization in scientific work has greatly increased in recent years. One form of it is the increased emphasis on publishing in international, typically English language, journals. Faculty continue to pursue individual efforts, especially in the Humanities and Social Science, however, in the aggregate, the relative share of single authored articles has declined.

[24] Ziman, J. (2001). *Real Science. What it is and what it means*. Cambridge University Press.

THE ICELANDIC SYSTEM OF HIGHER EDUCATION

This part of the appraisal describes the institutional background of the University of Iceland. The University of Iceland's activities are defined in several ways. First, they are defined by the laws on higher education in Iceland from 1997. Second, they are defined by the Icelandic national research policy that sets the framework for research within the country to a large extent. Third, they are defined by the internal policy of the University. That policy is made explicit in mission statements issued by the University, as well as in rules applying to different issues regarding research. Last but not least the University of Iceland, founded in 1911, is a relatively young institution compared to the old European universities. From its beginning, it has undertaken the roles of preserving the national and cultural heritage of Iceland and supplying the education and training for the nation's civil service, a need reflecting the still youthful age of Iceland as an independent democratic nation.

The Icelandic higher education system dates back to the foundation of the University of Iceland. Over the last three decades, new institutions of higher education have emerged in Iceland, providing greater diversity at the higher education level. Presently there are ten institutions of higher education in the country, most of which are run by the state. Private parties, with some state support, run three institutions. Institutions of higher education differ in the extent to which they engage in research and the number of programs of study offered. Opportunities for university education hence are now both more numerous and diverse then before. At the same time the number of students has almost doubled in the last decade.[25] They were around 7.000 in the year 1993 but almost 14.000 in the year 2002. The 1990s were a period of considerable change in the philosophy and the legal framework behind the provision of education at all levels in Iceland, with decentralization and quality control measures being introduced into schools and universities.

The legal definition of research activities at universities in Iceland

All universities in Iceland now operate under the general terms of the University Act passed in 1997, which provided for a new management framework, and individual acts concerning each university. The 1997 Act states in Article 2:

> A university is an educational institution which also carries out research, if so provided for in the rules applying to the activities of each individual institution. A university shall provide its students with the education to independently pursue scholarly projects, innovation and fine arts, and to perform various work in society for which higher education is required. Universities shall disseminate knowledge to the general public and provide society with services by means of their knowledge.

[25] Háskólamenntun: Námsframboð og nemendafjöldi (2003). Ríkisendurskoðun

According to national law, a university need not necessarily conduct research. In other words, a university can be called a university even though no research is conducted within its walls. Some Icelandic universities serve largely as teaching institutions with research on an individual rather than an institutional basis. Regarding the administration of universities, Article 3 states that:

> State-run universities shall be independent national institutions under the administrative authority of the Ministry of Education and administered as provided for in the specific legislation on each institution.

Article 5 states:

> The Minister of Education shall lay down general rules on the following aspects … the manner in which each university which has a research role is to fulfill its obligations concerning control of the quality of research and utilization of funding provided for research...

In Article 20 financial allocations are discussed:

> In determining the financial allocations to universities the following factors shall be taken into account:
>
> .....
>
> Allocations for research, innovation and development in those universities which have a research role, shall be based on the number of tenured instructors and special contributions to research projects and service institutions. The Minister shall set detailed rules on contributions for research.

The tone of the 1997 Act is that the primary task of the universities in Iceland is education. There is an emphasis on knowledge dissemination and on having universities serve society. Article 3 indicates that state-run universities shall be independent national institutions, but in later articles it is clear that the Minister of Education will set rules with regard to research quality and funding.

Research policy in Iceland

In Iceland the state carries out the role of formulating a national research policy and funding research activities. In early 2003 a new policy-making body, the Science and Technology Council (STC), was created to promote scientific research and research training and encourage technological progress in Iceland. The Council consists of five cabinet ministers as well as scientists from the universities and institutes and representatives of the business community. It is chaired by the prime minister and meets twice a year. Two boards, the science board and the technology board, function as working committees between Council meetings.

Iceland's national science and educational objectives are set forth in a series of reinforcing policy statements and strategic plans of the Science and Technology Policy Council (STC).[26]

In a five-year policy document adopted in December 2003, the Scientific and Technological Council lists actions that the government intends to take during its term of office (p.5):

- Increase the public resources intended for allocation from competitive funds and co-ordinate their operation to insure their optimum use for scientific and technical research and support to innovation in the Icelandic economy.
- Strengthen the role of universities as research institutions by building up and encouraging diversity in research at Icelandic universities through competition between individuals and research teams for research grants from competitive funds.
- Review the organization and work-methods of public research institutes, with the objective of uniting their strengths and coordinating their activities more closely with the universities and business sector.

The actions suggested by the STC are based on the premise that competition is a means of assuring quality. More research funding is to be allocated competitively and it is through competition that individuals or teams are to obtain funding for their research activities (STC, p. 9):

> Thus the mechanisms for funding university research in a modern competitive environment is therefore extremely important for implementing the policies of the Council.… increased appropriations to competitive funds would create the fresh opportunities for progress at universities, while competition would create the necessary quality control.

Coordination of funds leading to a better use of resources and cooperation between universities and public research institutes is also recommended (STC, p. 9).

> ….the Council also encourages increased cooperation among universities, research institutes and firms on research and research training. The participation of research institutes in master's and doctoral studies by providing research facilities and guidance is well suited to enhancing cooperation among these institutions and meeting the needs of the economy and society in general.

Research policy of the University of Iceland

During the first few decades of its history, the University was primarily a teaching institution. Support for research was minimal, as was research output. A more sustained

[26] *Vísinda- og tæknistefna*, samþykkt af Vísinda- og tækniráði þann 18. desember 2003 http://bella.mrn.stjr.is/utgafur/taeknistefna.pdf

commitment to research began to emerge in the 1960s and 1970s. At that time Icelandic society was undergoing extensive changes. The number of students at the University of Iceland was growing in concomitance with increased interest in sociological and political matters.[27] Technical and economic developments at the time resulted in declining employment prospects for those who had neither received higher education nor many years of general education.[28] Even college graduates in Iceland, as indeed, elsewhere in Europe, found diminishing and less attractive employment opportunities in the traditional occupation fields (civil service and in teaching) to where they up until then had been directed. Few graduates had ever been employed in private companies, whether the processing industry or services, especially outside of the Reykjavík area.[29]

Many within Iceland perceived those changes as a call for the university to convert from a school of officialdom into a scientific institute.[30] In a student convention, held at the university in the fall of 1969, the debate centered on the role of the University of Iceland. Many felt that it was too intertwined with the unchanged situation of the Icelandic society to be able to fulfill its most important role, which was to help shape the nation's future. It was argued that the University of Iceland was a school of officialdom, i.e. many of its graduates entered government service as professionals and researchers in government-funded research institutes.

The underlying premise to this challenge to the university's traditional areas of curricular coverage and emphasis on teaching was that rivalry between nations was guided by the proficiency and potential for making new knowledge. A powerful educational system and competent researchers were held to be a nation's greatest resource. In effect, the challenge was laid before the university to become a more active and successful player in the international scientific community.

The university has actively and effectively responded to this challenge in recent decades. Its emphasis on research has increased considerably. A scholar in the health sector describes the change in the following manner:

> When I started working here, approximately 25 years ago, the ones that wanted to conduct research were considered to be some kind of eccentrics. There was no stimulus. For many years we only got paid for teaching overtime and nothing else. But with the advent of a research fund this changed, conducting research started being compensated to a certain extent. This changed drastically with the advent of the research catalytic system in 1998. Being an active researcher has now started to pay off.

[27] *Haraldur Ólafsson /1996). A lecture given at the 20th anniversary of the Faculty of Social Sciences.*.
[28] Inga Dóra Sigfúsdóttir (1997). Námsbraut í almennum þjóðfélagsfræðum: Áfangi að stofnun nýrrar deildar. Íslensk félagsrit, Tímarit Félagsvísindadeildar Háskóla Íslands, 7.-9. 1995-1997.
[29] Háskólanefnd (1969). Efling Háskóla Íslands. Reykjavík: Háskóli Íslands.
[30] Þórir Kr. Þórðarson (1986). Frá embættismannaskóla til vísindaseturs. Tímarit Háskóla Íslands, 11-14.

Hence, the emphasis on research at the University of Iceland has been increasing (as across OECD nations) for at least two decades.

The main research policy objectives set forth by the University of Iceland are (1) strengthening Iceland's position in international science and (2) further developing Icelandic knowledge.[31] This emphasis on having the university increase its commitment to research is evident in various internal policy declarations as well as its own rules and goals concerning the development of graduate education.

The University of Iceland Act No. 41 was passed on 22 March 1999. It emphasizes the research role of the University beyond that provided for in the 1997 Act. Article 1 of the Act states that:

> The University of Iceland shall be an institute of scientific research and academic instruction, providing its students with the education necessary to carry out independent scientific undertakings and pursue various professions in society.

The pertinent legislation does not state clearly that the University of Iceland should be a top-quality research institution. On the other hand, its scientific policy indicates very clearly that it is to be a research university of the first rank.[32] The policy states:

> The University of Iceland is a research based university and part of the international scientific community. Its ambition is to be in the forefront of that community, with high-quality research conforming to scholarly standards in the international arena, and also being important for Icelandic society. Tutors and specialists at the University of Iceland have research freedom. Incorporated in this is that they choose their own subjects in their fields of scholarship. This involves responsibility and obligations. They shall publish their research in a scholarly forum requiring strict scholarly standards, and also endeavour to present them to the public whenever possible.
>
> The University wishes to offer vigorous research-based studies in as many disciplines as possible. Cooperation between fields of scholarship shall be promoted, and also diversity of the research carried out at the University. Research shall be carried out at the University of Iceland in collaboration with other universities, research institutions and companies, as opportunities and occasions afford.

Moreover, various university regulations give a clear indication of the type of demands that the University makes of its employees in the field of research. Indeed, the system of advancement within the university and rules that apply to the allocation of funding indicate that publication in the international arena is weighted heavily towards international research standards. The university's regulations clearly state that

[31] The University of Iceland Act no. 41, 22 March 1999; Rules for the University of Iceland, no. 458/2000; University of Iceland Aims and Measures 2003-2005.
[32] University of Iceland, Research and education policy. November 2004.. http://www.hi.is/id/1007042

Icelandic scholarly work must be comparable to the best that is done elsewhere, and it is specially mentioned that even research centering on specifically Icelandic phenomena must be acceptable on an international level. Thus the Board of the University of Iceland Research Fund considers that the projects most likely to generate results that meet international scholarly standards should receive priority when the University's research funding is allocated. The Fund's rules state *verbatim*: [33]

> Those evaluating applications for grants from the University of Iceland Research Fund will be asked henceforth to consider the likelihood that the proposed subject will produce results that will be published in the scholarly journals that set and stand up to stringent requirements. In general, applicants who have received grants from the Fund for three years without having published results in such journals cannot expect to receive further grants until publication has taken place.

The regulations go on to state that treatises, books and essays that have been published or approved for publication in recognized journals, either domestic or foreign, and been subject to peer review should also be taken into consideration. In other words, it is stressed that scientific work done by university teachers is recognized in the scientific community.

In 2002, the university released a document entitled *Aims and measures 2002-2005* that encapsulates its short-term strategic objectives. One of the three main objectives concerns strengthening the university as a research institution. Actions to be taken in this area include introducing a system for standardized quality measures on the effectiveness of research and teaching, increasing support for research and education in rural areas, an emphasis on the practical application of findings and a strengthening of contacts with domestic research institutes.[34] The report also contains references to the building of a science park, although few specific plans are mentioned. It also sets academic performance targets for 2005, including raising the number of post-graduate students from 10% to 20% (of total enrollments), raising the number of externally funded positions from 18 to 25, increasing non-direct funding from 35% to over 40% and increasing research funding to a level matching those granted for teaching.

Finally, a research policy is set forth in an agreement signed in 2003 between the Minister of Education and the university rector on a framework for the development of research activities at the University of Iceland.[35] The contract lists reciprocal responsibilities, in which both the University and the Ministry agree to carry out certain activities over the next few years. The agreement also emphasizes the importance of

[33] The University of Iceland Scientific Committee's rules for allocating funds from the University of Iceland Research Fund in 1999; text from the Website of the University of Iceland.
[34] See *Standards and requirements for quality of doctoral programmes at the University of Iceland* in Appendix IV.

[35] The document is included in Appendix III.

planning (foresight) activities. An underlying theme is the quality premise, i.e. the competitive strength of researchers at the university can be increased through the application of schemes built on quality assurance. In an interview with the rector of the University it was clear that he thought the research agreement was a milestone for the development of research at the University and provided both parties to the agreement a framework within which research at the University of Iceland could develop.

THE CONTRIBUTION OF UNIVERSITY RESEARCH

The contribution of faculty at the University of Iceland to research knowledge is the focal point of this evaluation. Having described the goals of the research policy within the university, we now study the performance of scholars within the university. The bibliometric analysis comprises several aspects.

First, macro indicators describing the production of scientific knowledge in Iceland in total are shown in comparison with the production of other nations. The numbers of scientific publications and citations of these publications are used as indicators of the productivity and impact of Icelandic science. Insofar as book output is concerned, the available bibliometric techniques in this discussion are unable to provide a solution. It is emphasized therefore that these statistics underestimate research in some areas, especially the humanities.

Second, micro indicators describing the production of knowledge at the University of Iceland is described. The chapter also discusses cooperation of Icelandic scholars, both locally, as well as with colleagues abroad, as international networking and collaboration has become increasingly relevant in research and developmental work.[36] The pattern of Icelandic scientific collaboration and the partners involved are analyzed based on co-authorship data.

Trends in contributions

First, we focus on the international aspect of scholarly endeavor among Icelandic scholars. Indicators of research performance based on bibliometric data show that the volume of research output from Icelandic scholars has increased considerably in the last 15 years. A study of data from the *Web of Science database*, which contains a list of all articles that have been published in ISI journals, reveals that in 1988 Icelandic scholars published 128 articles in internationally reviewed journals; in 2001, they published 452 articles in internationally reviewed journals. The format of publications has traditionally differed across academic disciplines.[37] Scholars in the natural sciences have primarily published their research findings in peer-reviewed journals, while books and monographs have been much more prevalent in the humanities. As an example of publication trends in comparison to other nations, in tables 1 and 2, we list information on publications and citations from the field of science and engineering. Table 1 shows that in 1988, Icelandic scholars within the field of science and engineering published 69

[36] Hage, J., and Hollingsworth, J.R. (2000). A strategy for the analysis of idea innovation networks and institutions. Organization Studies, 21 (5): 971-1004.

[37] Persson, Olle. 1985. Scandinavian social science in international journals. *Social Science Information Studies*, 5, p. 185-190.

articles in internationally reviewed journals; in 2001, they published 174 articles in international journals[38].

Similarly, the impact of their work has been increasing[39]. While papers of Icelandic scholars in this field were cited 314 times in the year 1992, they were cited 868 times in the year 2001 (see table 2). This is worthy of note, especially in view of the fact that smaller scientific communities find it more difficult to attain substantial circulation of references than others[40].

The results furthermore show that the position of Icelandic scholars on the international scene has been improving faster than those of several other comparable nations in the last few years. When taking into consideration the total population, in table 3, we see that in 1992 to 1996 Iceland was in twelfth place among the 22 nations, with 4.1 published articles per 1000 inhabitants. In 1998 to 2002 Iceland however moved up to the seventh place on the list, with 5.8 published articles per 1000 inhabitants.

[38] Similar information for a number of other countries is listed in Appendix table 1 in Appendix VII. See also regional and country portfolios of articles in international journals, by field for 1988 and for 2001 in Appendix tables 2 and 3 in Appendix VII.

[39] Source : Institute for Scientific Information, Science Citation Index and Social Science Citation Index. CHI Research, Inc. ; and National Science Foundation, Division of Science Resources Statistics. *Science and Engineering Indicators* (2004).
Similar information for a number of other countries is listed in Appendix table 4 in Appendix VII. is

[40] Luukkonen, T., Persson, O., Sivertsen,G. (1992). Understanding Patterns of International Scientific Collaboration. *Science, Technology and Human Values*, 17 (18): 101-126.

Table 1. Articles in Science and Engineering journals, by region and country in 1988 to 2001[41].

Region and country/economy	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Canada	21,391	22,501	22,792	22,903	24,180	23,824	24,565	24,532	24,538	23,077	22,796	23,417	22,873	22,626
United States	177,662	187,224	191,559	194,015	198,864	197,397	199,769	202,887	201,798	197,531	197,890	198,529	196,221	200,870
Austria	2,241	2,675	2,690	2,756	3,047	3,051	3,177	3,477	3,618	2,880	4,172	4,210	4,259	4,526
Belgium	3,586	3,905	4,103	4,169	4,431	4,512	4,949	5,260	5,583	5,509	5,822	5,924	5,739	5,984
Denmark	3,445	3,722	3,716	3,776	4,141	4,068	4,458	4,408	4,477	4,512	4,782	4,909	4,929	4,988
Finland	2,789	2,981	3,071	3,211	3,438	3,603	3,974	4,134	4,354	4,523	4,564	4,872	4,878	5,098
France	21,409	22,686	22,937	23,518	26,172	26,225	28,266	29,309	29,755	30,061	31,809	32,097	30,960	31,317
Germany	29,292	31,821	32,295	32,929	35,120	34,103	36,901	38,100	29,123	40,743	43,953	43,550	43,440	43,623
Greece	1,239	1,518	1,397	1,598	1,736	1,759	1,974	2,068	2,265	2,407	2,666	2,705	2,892	3,329
Iceland	69	68	89	104	105	122	137	158	149	147	177	136	154	174
Ireland	790	826	902	915	946	1,003	1,168	1,210	1,269	1,318	1,526	1,526	1,526	1,665
Italy	11,229	12,509	13,062	13,778	15,462	15,279	17,000	17,904	19,342	19,147	20,321	20,819	21,038	22,313
Netherlands	8,581	9,736	10,176	10,106	11,060	11,360	11,961	12,330	12,438	12,779	12,756	12,642	12,466	12,602
Norway	2,192	2,247	2,426	2,403	2,655	2,637	2,805	2,953	2,950	3,012	3,100	3,127	3,195	3,252
Portugal	429	510	587	640	712	794	914	989	1,090	1,250	1,404	1,765	1,813	2,142
Spain	5,432	6,116	6,837	7,269	9,267	9,759	10,534	11,343	12,234	13,040	13,786	14,860	14,776	15,570
Sweden	7,573	8,126	8,172	8,139	8,273	8,547	8,972	9,284	9,697	9,677	9,967	10,129	9,815	10,314
Switzerland	5,316	5,548	5,901	6,098	6,651	6,871	7,372	7,361	7,489	7,912	8,096	8,297	8,454	8,107
United Kingdom	36,509	38,195	39,069	30,950	42,404	42,456	45,436	45,993	47,904	46,183	27,916	48,965	49,485	47,660
Japan	34,435	36,569	38,570	39,590	44,143	43,339	46,692	47,603	50,392	50,171	54,685	56,134	55,413	57,420
Australia	9,896	10,730	10,664	10,742	11,452	11,929	12,695	13,387	13,911	13,955	14,710	15,186	14,700	14,788
New Zealand	2,0759	1,993	2,227	2,102	2,253	2,256	2,454	2,466	2,684	2,748	2,953	2,927	3,037	2,903

[41] Source : Institute for Scientific Information, Science Citation Index and Social Science Citation Index. CHI Research, Inc; and National Science Foundation, Division of Science Resources Statistics. Science and Engineering Indicators (2004).

Table 2. Citations of Science and Engineering articles, by region and country in 1992, 1996 and 2001[a1].

	1992		1996		2001	
Region and country/economy	**Number**	**Percent worldwide**	**Number**	**Percent worldwide**	**Number**	**Percent worldwide**
Canada	111,661	4.16	141,278	4.25	144,247	3.75
United States	1,389,314	51.75	1,624,607	48.85	1,678,293	43.63
Austria	11,023	0.41	16,437	0.49	23,775	0.62
Belgium	20,776	0.77	28,118	0.85	34,731	0.90
Denmark	20,271	0.76	26,288	0.79	32,558	0.85
Finland	14,704	0.55	21,493	0.65	30,461	0.79
France	116,453	4.34	153,159	4.61	187,325	4.87
Germany	157,285	5.86	207,673	6.24	274,520	7.14
Greece	3,359	0.13	5,132	0.15	8,971	0.23
Iceland	314	0.01	578	0.02	868	0.02
Ireland	3,440	0.13	4,639	0.14	8,148	0.21
Italy	54,805	2.04	83,353	2.51	115,461	3.00
Netherlands	57,498	2.14	76,260	2.29	91,238	2.37
Norway	10,221	0.38	13,079	0.39	16,212	0.42
Portugal	1,460	0.05	2,793	0.08	5,807	0.15
Spain	22,199	0.83	42,731	1.28	68,894	1.79
Sweden	48,980	0.82	57,349	1.72	66,394	1.73
Switzerland	43,605	1.62	58,346	1.75	69,675	1.81
United Kingdom	221,955	8.27	278,930	8.39	316,756	8.23
Japan	174,471	6.50	219,688	6.61	280,360	7.29
Australia	49,989	1.86	60,266	1.81	78,789	2.05
New Zealand	8,498	0.32	10,326	0.31	13,507	0.35

Tables 3 and 4 show that Switzerland is at the top with 7.8 articles per 1000 inhabitants in the earlier period and 9.4 articles in the later one. In a number of studies, Switzerland ranks among the world leaders in research output, impact, and value for money spent[42]. Further, Sweden ranks number two by publishing 6.9 articles per 1000 inhabitants in the earlier period and 8.4 in the later. In biotechnology specifically, Sweden is viewed as offering the best climate for research and innovation in Europe, as well as the highest-quality work force. Denmark ranks number three with 5.8 articles per 1000 inhabitants in the former period but 7.1 in the latter period. In Canada the number of articles per 1000 inhabitants does not change over these two time periods, which causes Canada to move from the fourth place in the earlier period to the eleventh in the latter. Finland moves from fifth place to the fourth as the number of articles increases by 33%. The Netherlands and Britain follow suit as noted before. Iceland moves upwards and now ranks higher than nations such as the US, Norway, Australia and New Zealand.

A perusal of data from the *Web of Science database* reveals that, during the period from 1999 to 2002, scholars at the University of Iceland and related institutes were the authors of a majority, or approximately 80% of all articles that were written, either partially or entirely, at Icelandic universities, institutions and companies. Thus approximately 20% were employees at other Icelandic institutes devoted to scientific and scholarly work not in cooperation with the University of Iceland. It is worth noting that a majority of articles written at the University of Iceland, were written at institutes related to the university, not at departments within the University. Scholars at other universities than the University of Iceland were the authors of a total of 3% of articles. DeCode, with a ratio of 4%, had the highest authorship percentage. About 38% of articles with authors at DeCode, were co-authored with faculty members at the University of Iceland.

[42] See for example May, R. (1998). Science Priorities: The Scientific Investments of Nations. *Science,* 281: 49-51

Table 3. Scientific publications in selected countries. Total number of articles 1998-2002[43]

Country	Number of articles	Number of articles per 1000 capita	Percent increase between 1992-1996 and 1998 -2002
Switzerland	67.453	9.4	23,68%
Sweden	74.111	8.4	22,08%
Denmark	37.942	7.1	24,69%
Finland	35.550	6.9	32,85%
Netherlands	93.457	5.9	18,50%
UK	345.466	5.8	18,54%
Iceland	**1.616**	**5.8**	**47,18%**
New Zealand	21.675	5.7	30,60%
Australia	105.306	5.5	26,43%
Norway	24.375	5.4	25,02%
Canada	166.504	5.4	3,17%
Belgium	49.451	4.8	32,25%
USA	1.267.948	4.6	5,90%
Austria	34.693	4.3	45,38%
Germany	322.969	3.9	27,55%
France	233.850	3.9	20,99%
Ireland	13.388	3.5	50,63%
Japan	344.200	2.7	22,71%
Spain	108.272	2.7	51,59%
Italy	151.799	2.6	31,71%
Greece	23.885	2.2	58,86%
Portugal	15.116	1.5	114,41%

[43] Source: NIFU/ISI (NSI).

Table 4. Scientific publications in selected countries. Total number of articles 1992-1996[44]

Country	Number of articles	Number of articles per 1000 capita
Switzerland	54.537	7.8
Sweden	60.707	6.9
Denmark	30.429	5.8
Canada	161.390	5.5
Finland	26.760	5.3
Netherlands	78.867	5.1
UK	291.436	5.0
New Zealand	16.596	4.7
Australia	83.293	4.7
USA	1.197.325	4.6
Norway	19.497	4.5
Iceland	**1.098**	**4.1**
Belgium	37.393	3.7
France	193.287	3.3
Germany	253.201	3.1
Austria	23.864	3.0
Ireland	8.888	2.5
Japan	280.499	2.2
Italy	115.252	2.0
Spain	71.425	1.8
Greece	15.035	1.4
Portugal	7.050	0.7

[44] Source: NIFU/ISI (NSI).

International collaboration

Collaboration, including international collaboration, is becoming an increasingly important feature of research and developmental work. Studies have shown that multi-authored papers generally are more highly cited than single-author papers. Hence their impact is greater than papers written by single scholars.[45] Similarly, internationally co-authored papers have been found to be cited more than twice as frequently as papers coming from single institutes within a single country. Other studies have also shown that papers by many authors, from several countries have the highest average impact.[46] A single co-publication hence may reveal much about the attractiveness of scientists and institutes nationally as well as internationally. Scholars have presented such findings as evidence that policy makers should facilitate participation in international projects.

The analysis in this section is based on data retrieved from the Science Citation Index (SCI), Social Science Citation Index (SSCI), and Arts and Humanities Index (AHI). The results show that between 1999 and 2002 approximately 70% of papers by Icelandic scholars were written jointly with authors from institutions from other countries. This is a higher proportion of articles written in international collaboration than in other Scandinavian countries. Thus, in Norway internationally co-authored papers were 43% of all articles in the year 2000. Similarly, 40% of Finnish papers were co-authored by researchers from other countries in the year 2000.[47] The findings are in line with studies that have shown that smaller countries collaborate internationally more extensively than larger countries.[48] The most likely reason for this is the fact that researchers from small countries often have to look abroad for colleagues and partners within their own specialty. Small scientific budgets and the need for cost-sharing and access to facilities abroad are other reasons.[49]

The countries that Icelandic scholars most frequently collaborate with are shown in Figure 1. Icelandic scholars in general collaborate most with colleagues from Sweden, the United States, Denmark, England and Norway. As shown in Figure 1, about 27% of Icelandic papers were co-authored with authors from Sweden, which is thus the most important individual country concerning co-authorship. A quarter of Icelandic papers in

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[45] Aksnes, D.W. (2003). A Macro Study of Self-Citation. *Scientometrics, 56 (2*): 235-246

[46] Katz, J.S., and Hicks, D. (1997). How much is a collaboration worth? A calibrated bibliometric model. *Scientometrics, 40 (3):* 541-554

[47] Persson, O., Luukkonen, T., and Halikka, S. (2000). *A Bibliometric Study of Finnish Science*. VTT, Group for Technology Studies. Espoo.

[48] Luukkonen, T. (1992). Is Scientists Publishing Behavior Reward-Seeking? *Scientometrics*, 24 (2): 297-319.

[49] Wendt, K., Slipersæter, S. and Aksnes, D. W. (2003): Internationalisation of Research in: Gornitzka, Åse, Magnus Gulbrandsen and Jarle Trondal (eds): Internationalisation of Research and Higher Education – Emerging Patterns of Transformation, Report 2/2003.

this period were co-authored with authors from the United States and about 17% with authors from Denmark and England. A more detailed list of countries collaborating with Icelandic scholars is found in Appendix VIII. There we see that Icelandic scholars collaborate with scholars from about fifty countries in this four year period.

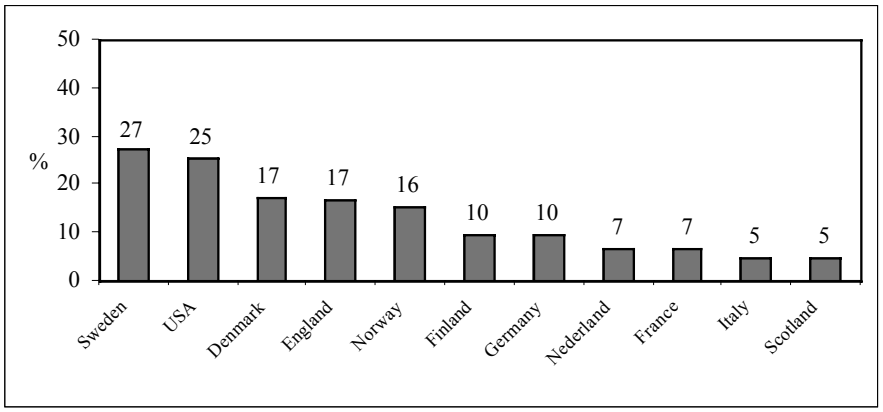

Figure 1. The countries that Icelandic scholars most frequently collaborated with in the years 1999-2002.

In a pioneering work, Derek de Solla Price showed that multiple authorship had been increasing[50]. These findings have later been confirmed by a large number of similar studies[51]. In the years 1995 to 1997, about 15 percent of papers world-wide were written jointly by authors from different countries[52]. In 1989 to 1991 the proportion was less than 10 percent.

Contribution of scholars at the University of Iceland

In this section we present an overview of academic performance, first for the university as a whole and then within each academic discipline in the years 1999 to 2002. The database consists of information that is gathered on a yearly basis from faculty at the University of Iceland. The data is based on information from 278 faculty members. The number of faculty is fairly low and some departments within the University are very small, with less then 10 faculty members. The data hence is categorized by subject fields, not by departments/faculties. The fields are the Humanities, Social Science, Health Science, and Science and Engineering.

In order to give a broad view of the university, we start by showing results for the university as a whole and then split the data by subject fields. Figure 2 reports descriptive data of research points for faculty at the University of Iceland in the years

[50] Price, D.J. (1963). *Little Science, Big Science and beyond.* New York: Columbia University Press.
[51] Merton and Zuckerman (1973); Wendt, K., Slipersæter, S., and Aksnes, D.W.
[52] Hinze, S. , Aksnes, D.W., and Sivertsen, G. (2001). *Bibliometric Analysis of Norwegian Research Activities.* Norwegian Institute for Studies in Research and Higher Education (NIFU).

1999 to 2002[53]. The mean number of research points for professors, associate professors and assistant professors in the four year period is 94.3, while the median is approximately 77. The first quartile or 25% of the faculty gets approximately 32 points or less in the four year period, while 75% get approximately 139 points or less. The Figure shows that the range is greatest in the fourth quartile, from approximately 140 points to 480 points.

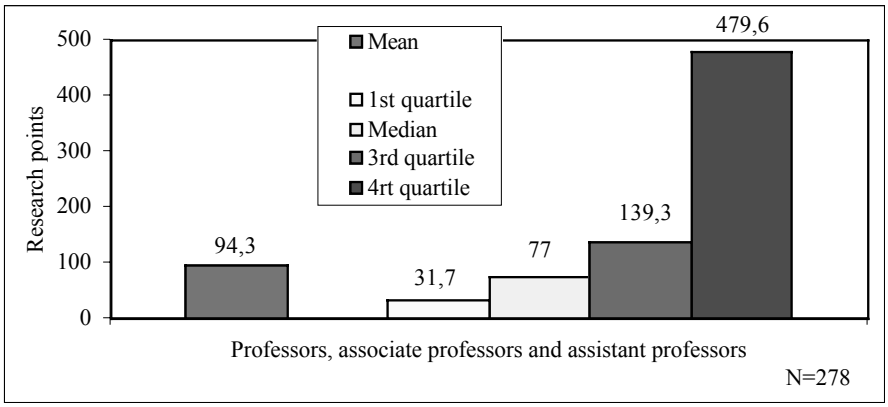

Figure 2. Research points among faculty at the University of Iceland in 1999 to 2002.

Figure 3 reports data on research points in the same period, separately for professors and associate and assistant professors. The Figure shows that professors are more productive researchers than the associate and assistant professors at the University of Iceland. The mean research points in that group are approximately 116, while associate and assistant professors have a mean of 69 research points. Furthermore, members within each quartile among professors have more research points than in the group of associate and assistant professors in the four year period.

[53]The University of Iceland gathers extensive data from faculty about their scholarly activities, including numbers of articles by professors in international academic journals (in SCI, SSCI and AHCI), the number of articles by them in other journals (i.e. not in the three former mentioned databases), the number of lectures, i.e. conference presentations, plenum and keynote lectures and editorship of journals. These data served as a foundation for a database created by the research team. A list of criteria and research points appears in Appendix II.

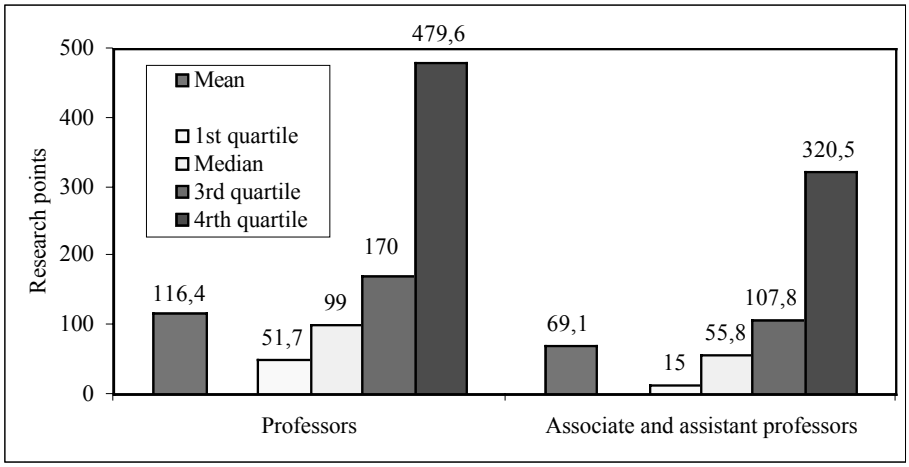

Figure 3. Research points among professors, associate professors and assistant professors at the University of Iceland in 1999 to 2002.

A closer look at the data shows that 26 faculty members at the University, or 9%, have 200 research points or more in the four year period. Of these 26 scholars, six are in the Faculty of Social Sciences (18% of the department), three are in the Faculty of Business- and Economics (15% of the department), one in the Faculty of Theology (14% of the department), seven are in the Faculty of Philosophy (12% of the department), two are in the Faculty of Pharmacy (33% of the department), one is in the Faculty of Medicine (4% of the department), four are in the Faculty of Natural Sciences (6% of the department) and two in the Faculty of Engineering (9% of the department). Scholars in the Faculties of Law, Odontology and in the Faculty of Nursing and Physiotherapy did not have 200 research points or more in the four years under study. Twenty two out of twenty six of these scholars are professors.

Analyzing the data by gender (men = 209/women = 69) indicates that on average women and men have similar research points. On average men get 96 research points while women get a little less than 90 points on average. Also the median research points are the same. This suggests that men and women at the University of Iceland are equally productive researchers (Figure 4).

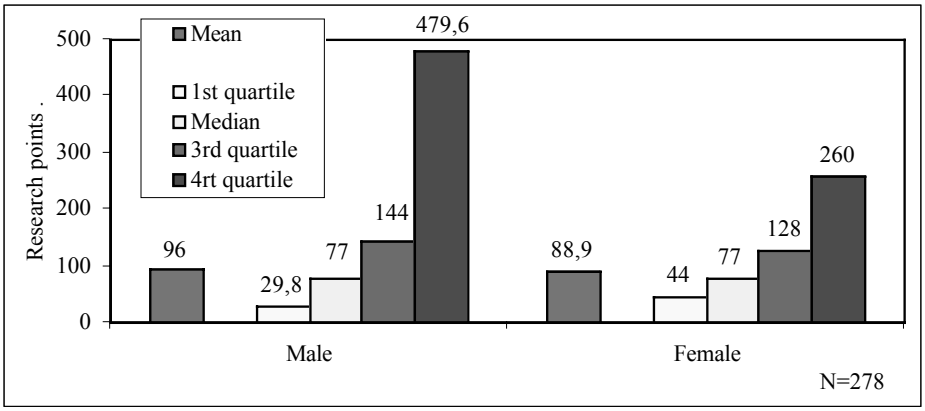

Figure 4. Research points among male and female faculty members at the University of Iceland in 1999 to 2002.

The variance in scores in the two groups differs somewhat, though. It is higher for males (SD=88) than for females (SD=63), indicating that there are both more highly productive and unproductive scholars among male faculty relative to female researchers.

Analysis of the data by age shows a weak positive correlation between research efficiency and age. The mid-age group is the most efficient while the oldest and the youngest groups are not as active. The point of view held by some is that the oldest group is the least active in research at the university. This standpoint for instance became evident in an interview conducted with a scholar in the field of Health Sciences:

> … there are a number of University faculty members who do no research at all. This is partially a problem lingering on from the past, I think. I have always said that many faculty members of the older generation, those who are gradually retiring, did little or no research. We all know this. But perhaps the reason for this is that there were no research facilities available when these people completed their education. They were put in teaching positions; they worked for the government, served on committees, and so forth. They worked like this for a few years, and one doesn't have to stay very long in such jobs, and then they never managed to make their way up out of the rut. They've been beaten down. This group who are, say, over 60 now, it's not actually their fault. It's impossible to tell them now that we're going to take money away from them, that now they have to do more research work – that's no answer for these people.

Analysis of the data reveals that this opinion is partly correct. Hence, the oldest faculty members turn out to be the least productive group. It appears however that the youngest group of scholars at the university is also less active than the mid-age group, which is a matter of concern for the university.

The analysis of total research points shows that there are some very active researchers in most areas within the University of Iceland. Those in theology, law, pharmacy and social sciences have the highest median. About half of the researchers attained 100 points or more over the four year period.

A closer analysis of the data reveals that a part of the employees of the University of Iceland is not active in research. Figure 2 indicates that one fourth of the employees received 32 research points or less in the period 1999 to 2002. Furthermore, it appears that one fifth of the employees received less than 15 research points in the same period.

The high proportion of employees at the university not active in research raises concern. Interviews with faculty and administrators adduced several explanations for this low productivity. Among them were: lack of research funding in general, especially lack of competitive research funds, inadequate research facilities and equipment, lack of minimum requirements in research at the University and too little flexibility in being able to buy oneself out of teaching.

Approximately 96% of the professors, associate professors and assistant professors within the field of Social Science and the field of Humanities believed it to be very or rather important to increase financial resources for research at the university.[54] Also about half of the participants from the field of Social Science and the field of Humanities considered it most important to increase financial support to research, where one fourth considered it most important to increase financial support to undergraduate teaching and one fourth to graduate teaching.[55] Furthermore more than half of the participants from the field of Social Science and the field of Humanities considered it very or rather important to increase financial resources for research by reinforcing competitive funds.

Presently, there are no minimum requirements for accomplishments at the university, with the exception of a requirement for a minimum of 15 research points a year at the transferal of the work quota at the age of 55. The transferal of a work quota at the age of 60 requires a minimum of 25 research points a year. It is of great importance to the university to activate more employees to do research.

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[54] The results in the fields where the response rate was above 60% are specifically denoted here, i.e. the field Social Science and the field of Humanities (together with response rate of 70.4%). Approximately 96% of the professors, associate professors and assistant professors in the field of Health Science and the field of Science and Engineering who answered the survey were of the same opinion.

[55] The results in the fields where the response rate was above 60% are specifically denoted here, i.e. the field of Social Science and the field of Humanities (together with response rate of 70.4%). Approximately two thirds of the professors, associate professors and assistant professors in the field of Health Science and the field of Science and Engineering who answered the survey were of the same opinion.

The importance of flexibility at work became obvious during the interviews; people find it important to be able to buy themselves out of teaching to do research. A scholar in the field of Health Sciences had the following to say:

> There are a lot of things that need to be changed. First of all, they need to build up the Research Fund, and gradually things have to change to the point where teachers who want to conduct research and know how to do so can teach a lighter load without a salary cut so that they can have time for their research work.

During the interviews the notion emerged that the dispensation of government funding to the university based on a fixed allocation formula tied to the number of students it enrolls accentuates the role of the university as an educational institution but counteracts its objective of having the university become a top-quality research university. The formula provides incentives to the school to increase the number of students. At the same time, government funding to research is not advancing and therefore decreasing relative to contributions to teaching.

Other factors besides financial resources were advanced as explanations for the low research activity by a number of University personnel. One explanation was that the university's administration itself inhibited research activity. Communication channels between administrators and faculty were described as taking too long and frequently not leading to definite outcomes. The system was also described as cumbersome and often uneconomic. Frequently mentioned was that despite the professed goal of the university of becoming a top-quality research university, its administration did not seem to appreciate the importance of research.

Criticism of the university administration was evident in a survey of faculty attitudes. Around 75% of the professors, associate professors and assistant professors either strongly or rather strongly agreed with the proposition that administrative independence of the departments within the university should be increased.[56] In addition, a little less than 70% of the professors, associate professors and assistant professors believed that financial independence of the departments should be increased.[57] The interviews revealed general satisfaction with the department of research affairs (Rannsóknarsvið) of the University. Table 5 shows in more detail the nature of research activities among faculty at the University of Iceland.

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[56] The results in the fields where the response rate was above 60% are specifically denoted here, i.e. the field of Social Sciences and the field of Humanities (together with response rate of 70.4%). Approximately 86% of the professors, associate professors and assistant professors in the field of Health Sciences and the field of Science and Engineering were of the same opinion.

[57] The results in the fields where the response rate was above 60% are specifically denoted here, i.e. the field of Social Sciences and the field of Humanities (together with response rate of 70.4%). Approximately 90% of the professors, associate professors and assistant professors in the field of Health Sciences and the field of Science and Engineering were of the same opinion.

Table 5. Points for bibliometric contributions for professors, associate professors and assistant professors at the University of Iceland in the years 1999-2002 (N=278).

Bibliometric criteria	Sum	Mean	Median	Std	Range
Articles in refereed journals listed in ISI database	4552	16.4	0	28.4	0-183
Articles in refereed journals not listed in ISI database	3630	13.1	10	16.2	0-100
Books	2479	8.9	0	20.6	0-110
Book chapters	2281	8.2	0	14.5	0-80
Papers in conference proceedings	2882	10.4	0	20.2	0-153
Scientific reports or memoranda	2785	10.3	6.6	11.5	0-60
Reviews in academic publications	104	0.4	0	1.3	0-12
Plenary lectures at international conferences or keynote addresses at conferences	824	3.0	0	6.4	0-40
Lectures at scientific conferences	3669	13.2	9	16.4	0-171
Lectures for the academic community	593	2.1	1	2.6	0-13
Editors of academic journals and academic books	423	1.5	0	3.4	0-20
Members of editorial boards of academic journals and academic books	575	2.0	0	4.2	0-24

The table shows that mean points for articles published in international journals, listed in the ISI database, for faculty at the University of Iceland, is 16.4 over the period from 1999 to 2002.

A closer look at the data, shown in Figure 5, reveals that about 53% of faculty members published an article in an international journal during the period under study. About 12% were co-authors with colleagues on a publication, but did not attain 15 points which are the points obtained by a single author for one published article in a refereed journal. Approximately 9% of the faculty published one article in this four year period and 9% published four articles or more in this period, which means that they published one or more article per year. This implies that a part of the university faculty are very active in international scholarly activities.

It is well known that publishing patterns differ between fields. Researchers in the Health Sciences and in Engineering and Science are more likely to publish their results in journals while those in Humanities and Social Sciences are more likely to write books. An analysis carried out here in Iceland a few years ago showed that researchers in the Social Sciences actually do both. The analysis also showed that researchers in Health Sciences and Natural Sciences are most likely to publish peer reviewed articles in international journals.

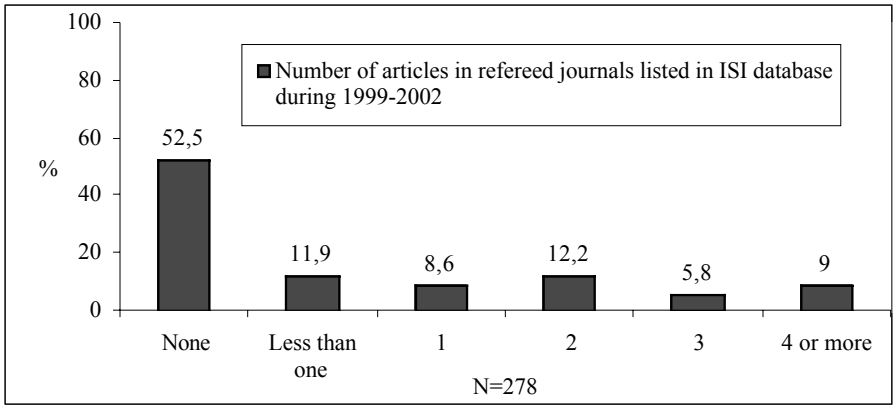

Figure 5. The faculty of the University of Iceland, number of articles in refereed journals listed in ISI database during 1999-2002.

Furthermore the results shown in Table 5 reveal that mean points for articles in refereed journals not listed in ISI databases are 13.1 in the four year period. Figure 6 shows that approximately 60% of the faculty members at the University of Iceland published articles in refereed journals that are not listed in the ISI (Institute for Scientific Information) database in the four year period. Journals included in this category are for example Icelandic journals, such as *Íslenskt mál*, *Jökull*, *Rit fiskideildar*, *Skírnir*, *Tímarit sálfræðinga* and *Læknablaðið* as well as a number of journals in other languages.

Approximately 10% were co-authors with colleagues on a publication, but did not attain 10 points which are the points obtained by a single author for one published article in a refereed journal other than ISI. Approximately 16% of faculty members published one article in non-ISI refereed journals in the four year period. Finally a little less than 23% published two to three articles and about 12% published four articles or more in non-ISI refereed journals in the period 1999 to 2002.

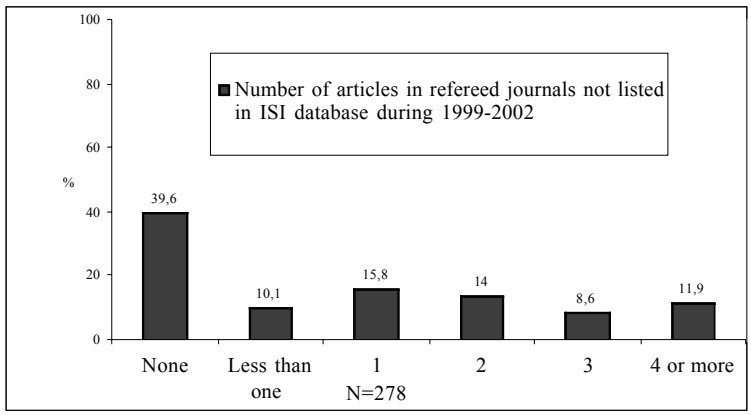

Figure 6. The faculty of the University of Iceland, number of articles in refereed journals not listed in ISI database during 1999-2002.

Table 5 shows that mean points for books are 8.9 in the period under study. A closer look at the data, in Figure 7, reveals that approximately 22% of faculty members at the University of Iceland published a book in the period 1999 to 2002. Approximately 9% co-authored a book, while 13% published one book or more.

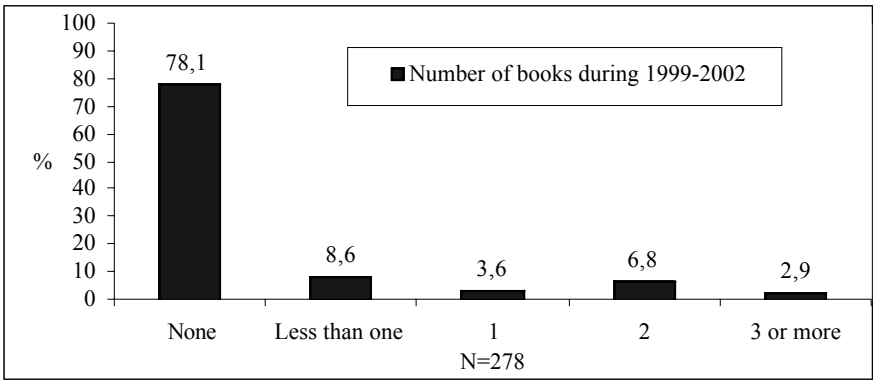

Figure 7. The faculty of the University of Iceland, number of books during 1999-2002.

In recent years, studies have revealed a dramatic change in publication practices in all academic fields. In particular, in fields that traditionally have emphasized book publications, scholars are increasingly publishing their work as journal articles[58].

Referring back to Table 5, mean points for book chapters in the period under study were 8.2. Approximately one third of faculty members at the University of Iceland wrote one or more book chapters in the years 1999 to 2002 (not shown). Mean points for papers in conference proceedings among faculty of the university were 10.4. Over one third of faculty members at the university published one or more papers in conference proceedings during this period (not shown).

Table 5 also reveals that on average faculty members at the University of Iceland got 3 points for plenary lectures at international conferences or keynote speeches in the period under study. One fourth of faculty members at the university had given plenary lectures or keynote addresses at conferences (not shown). Almost 9% of faculty members gave three or more plenary lectures or keynote addresses in the four years period. Appendix IX shows correlations between different academic endeavors. The table shows a significant positive correlation between publishing in ISI journals and lecturing at international conferences, r = .29.

[58] Persson, Olle. 1985. Scandinavian social science in international journals. *Social Science Information Studies*, 5, p. 185-190.

Sigfusdottir, ID, and Thorlindsson, Th. (2000) *Grunnvísindi á Íslandi* [Basic Science in Iceland: Performance and progress]. Reykjavik.

To analyze the relationship between the type of research activity faculty engaged in and their total research point scores, faculty members at the University of Iceland were divided into three groups according to their research activity, i.e. according to the total research points in years 1999 to 2002 (Table 6). The points were divided in the following fashion according to lowest, mid and highest third: The lowest third got between 0 and 47 research points in total in years 1999 to 2002. The mid-third received 48 to 113 points in the period and the highest third obtained 114 to 480 research points in total in the period.[59] These results indicate that publication practices are similar in all three groups. The greatest difference can be seen in the writing of books. Moreover, publications in international cited journals and articles in other cited journals are most important in the total research score of all three groups.

Table 6. Proportion of points for bibliometric contributions for three categories of faculty at the University of Iceland in years 1999-2002 (N=278).

Bibliometric criteria	Lowest third	Mid third	Highest third
Proportion of points for articles in refereed journals listed in ISI database	20,5%	14.8%	18.1%
Proportion of points for articles in refereed journals not listed in ISI database	16.5%	15.2%	13.0%
Proportion of points for books	3.5%	7.5%	10.9%
Proportion of points for book chapters	2.7%	8.4%	9.4%
Proportion of points for papers in conference proceedings	10.2%	10.2%	11.4%
Proportion of points for scientific reports or memoranda	13.6%	12.8%	10.0%
Proportion of points for reviews in academic publications	0.4%	0.3%	0.5%
Proportion of points for plenary lectures at international conferences or keynote addresses at conferences	2.3%	3.3%	3.2%
Proportion of points for lectures at scientific conferences	16.1%	14.4%	13.6%
Proportion of points for lectures for the academic community	4.0%	2.5%	2.0%
Proportion of points for being editors and members of editorial boards of academic journal/books	1.8%	4.0%	3.7%
Proportion of points for posters for scientific conferences/meetings	6.3%	3.9%	3.4%

The group that obtains the most research points receives relatively more points for the writing of books and chapters than the group that is not active in research. Furthermore, there are implications that the group that receives the most research points obtains relatively more points for smaller projects than the two other groups.

[59] The percentage in each third do not add up to a 100% of research points, because of some non-substantial factors that were not examined specifically. Those factors are points gained for doctoral theses and points gained for translations, patents, software and other similar academic contributions.

The effects of the performance based salary system

As discussed above the university operates a formal system of performance based compensation and incentives. The rules are intended to evaluate researchers' contribution and influence at the international and the domestic level. Therefore, the University takes into consideration the researcher's published articles in internationally recognized journals and peer-reviewed Icelandic periodicals, as well as the number of books that the scholar has published and the number of citations of that scholar's work. In this way, the rules evaluate both Icelandic scientists' contribution to the international arena as well as their contribution to the furtherance of Icelandic history and culture.

It is the general opinion of the professors, associate professors and assistant professors that the research incentive program has a stimulating effect on the research activity of the personnel. The attitude survey revealed that nine out of every ten professors, associate professors and assistant professors in the fields of Social Sciences and Humanities strongly or rather strongly agree with the notion that the research evaluation program of the university encourages research.[60] The system is however not undisputed, especially regarding the criteria used. According to scholars within the field of Humanities, for example, books should be considered more important in the evaluation than they are now, and qualitative assessment should be strengthened. In their opinion it should be possible to gain more points for books. According to them books are a significant contribution and have to undergo a strict peer evaluation. A scholar within the field of Humanities had the following to say, regarding the incentive program:

> Like I said in the beginning I am a resolute supporter of efficiency evaluation and have always been. I reckon, since you ask about the policy of the university – that aimless policy prevails. That is the attitude I sense. First, for any university to agree to allow its own employees, academic employees, to determine their own evaluation, is I believe unprecedented. Secondly, I believe that any other academic institution would not have accepted to have a party such as the contract Committee (Kjaranefnd) set that assessment without consulting with the institution (Háskóli Íslands). That brings me to the second main point in our criticism regarding this assessment. And that is the fact that one set of criteria has been made for all the departments of the University – this, in our opinion, is ridiculous... It should e.g. have been defined in advance which faculties have something in common in this situation. It might be that the Department of Philosophy and the Faculty of Social Sciences could have agreed on some common criteria –

[60] The results in the fields where the response rate was above 60% are specifically denoted here, i.e. the field of Social Science and the field of Humanities. Approximately 80% of the professors, associate professors and assistant professors in the field of Health Science and the field of Science were of the same opinion.

Within the field of Health Sciences and the field of Science and Engineering the opinion prevails that articles in distinguished science journals should weigh more in the evaluation than they presently do. In the interview the importance was stressed for acknowledging the impact factors of journals in the evaluation of international journal articles and thereby giving people the chance to receive more points for articles published in the "best" journals. A scholar in the field of Health Sciences says:

> … Icelandic work gets a favorable judgment, in my opinion. Reports and the like, which I perhaps don't consider being research as such – or if one were to take these into account, then one must measure some sort of "impact" on the scientific discipline. This we do by publishing in peer-reviewed international journals. Then others in the same field read the published material and cite it. But there are various Icelandic journals that perhaps are valued more than they should be which has led to the success of many articles, and even reports and such. A good example of this is theology, which gets the highest points despite its not being the wellspring of international articles.

According to the attitude survey two thirds of the professors, associate professors and assistant professors in the field of Social Sciences and the field of Humanities claim to be rather or very satisfied with the criteria for research/science work in the research evaluation program of the university.[61]

Analysis of the data reveals that articles published in cited international journals have equivalent weight to books and book-chapters in the total research score of the faculty members of the University of Iceland. Presuming the similarity of research efficiency of scholars, whether they publish their results as articles or books, it may be assumed that the evaluation program gives a fair portrayal of research efficiency. It furthermore indicates that the University of Iceland puts equal importance on its twofold role; aimed both at strengthening Iceland's positions in international science and at further developing Icelandic knowledge.

During the interviews, the importance of taking more indicators of research performance into account than before was pointed out by some. Such ideas have been gaining ground for the past years and are in accordance with the changes that the researcher's role has undergone. Their roles are now much more diverse than before, as mentioned previously in this report. It should be kept in mind though that the goal of scientific work is the acquisition and distribution of *reliable* knowledge.[62] The goal thus implies that both the acquisition and the distribution of knowledge have to go hand in hand and that the knowledge is *reliable* in the sense that it has been subjected to a strict

[61] Accordingly, approximately two thirds of the professors, associate professors and assistant professors at the field of Health Science and the field of Science, participating in the survey, claimed to be rather or very content with the criteria.

[62] Merton, R.K. (1996/(1942)). *The Ethos of Science. On Social Structure and Science.* Chicago: The University of Chicago Press.

peer review. Knowledge that has not undergone and passed peer review in this sense then, is not *reliable* knowledge. This should be kept in mind when discussing the idea of strengthening the criteria.

An example of a criterion often specified as new is the membership of a company's board. The knowledge distributed there has not always undergone peer review. Thus, the membership of a board cannot by itself be considered a valid criterion for a research accomplishment, although it may be a valuable addition to other more traditional criteria.

The field of Social Science

The field of Social Science includes the Faculty of Social Sciences, the Faculty of Law and the Faculty of Business and Economics. The data on the field of Social Science are based on information on 64 faculty members.

Figure 8 shows information on means and distribution of research points for faculty in the field of Social Science in the years 1999 to 2002. Mean research points in the four year period is 105.7, while the median is 79.5. The first quartile of the faculty gets 33.5 points or less in the four year period, while 75% get approximately 165 points or less. As we saw for the university as a whole, the distribution is also greatest here in the fourth quartile, from 165 points to 474 points.

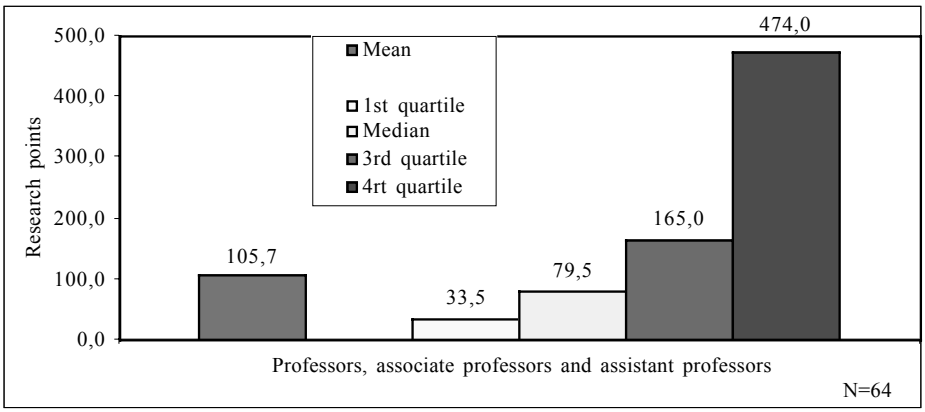

Figure 8. Research points among faculty in the field of Social Science in 1999 to 2002.

In Figure 9 we see the number of research points in the same period, separately for professors, associate professors and assistant professors. Within the field of Social Science, the distribution of research scores is greater among professors than associate and assistant professors. While the first quartile among professors gets approximately 57 research points or less, the fourth quartile gets research points ranging from 188 to

474. Professors get 141.3 mean research points, while the mean among associate and assistant professors is 74.3.

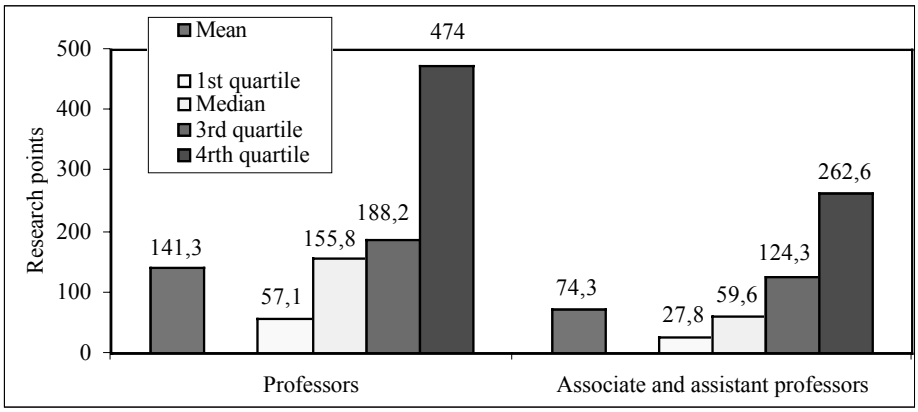

Figure 9. Research points among professors, associate professors and assistant professors at the field of Social Science in 1999 to 2002.

Table 7 reports information on points for different scholarly activities among faculty in the field of Social Science. Faculty members in the field of Social Science got 12.3 mean points for publishing papers in internationally refereed journals in the years 1999 to 2002. Figure 10 shows that about 37.5 % of faculty members in the field of Social Science published an article in an international journal, listed in the ISI database, in the period under study. Approximately 9% were co-authors with colleagues on a publication, but did not attain 15 points which are the points given for one published article in an internationally refereed journal. About 28,5% of faculty members published one article or more in the period under study.

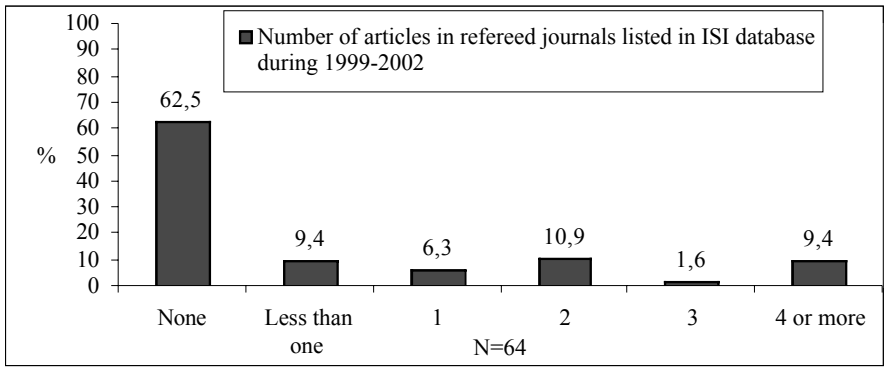

Figure 10. Field of Social Science, number of articles in refereed journals listed in ISI database during 1999-2002.

Table 7. Points for bibliometric contributions for professors, associate professors and assistant professors in the field of Social Science[63] in years 1999-2002 (N=64).

Bibliometric criteria	Sum	Mean	Median	Std	Range
Articles in refereed journals listed in ISI database	783	12.3	0	22.6	0-111
Articles in refereed journals not listed in ISI database	1006	15.7	10.0	19.9	0-100
Books	942	14.7	0	25.8	0-100
Book chapters	841	13.1	6	16.9	0-71
Papers in conference proceedings	692	10.8	10	13.3	0-60
Scientific reports or memoranda	821	12.8	8.5	14.5	0-60
Reviews in academic publications	41	0.6	0	2.0	0-12
Plenary lectures at international conferences or keynote addresses at conferences	133	2.1	0	4.6	0-20
Lectures at scientific conferences	957	14.9	9.0	16.1	0-64
Lectures for the academic community	179	2.8	2.0	2.8	0-11
Editors of academic journals and academic books	84	1.3	0	3.0	0-12
Members of editorial boards of academic journals and academic books	179	2.8	0	5.2	0-24

Table 7 shows that faculty members got 15.7 mean points for articles in refereed journals that are not listed in the ISI databases. In Figure 11 we see that approximately 66% of the faculty members in the field of Social Science published articles in refereed journals that are not listed in the ISI data base, in the four year period. Journals included in this category within the field of Social Science are for example Icelandic journals, such as *Íslensk félagsrit* and *Uppeldi og menntun* as well as a number of journals in other languages. About 17% of faculty members published one article in non-ISI refereed journals in the four years period, while about 22% published two or three articles. About fifth of faculty members published four articles or more in non-ISI refereed journals in the period 1999 to 2002.

[63] The field of Social Science includes the Faculty of Social Sciences, the Faculty of Law and the Faculty of Buisness and Economics.

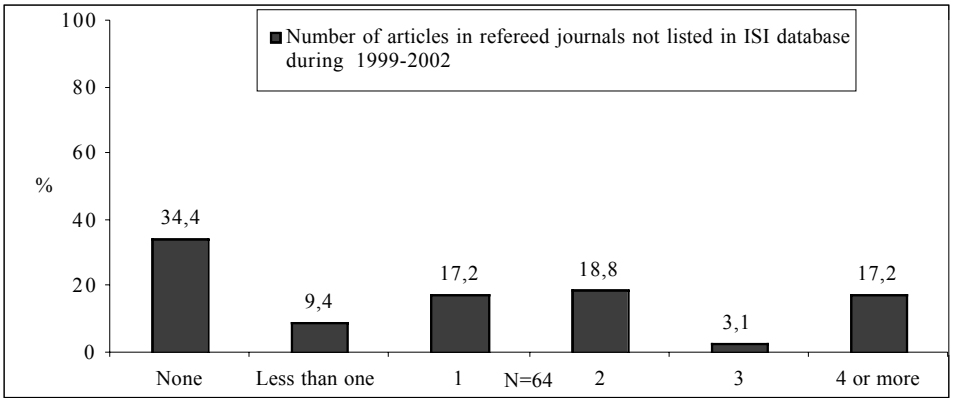

Figure 11. Field of Social Science, number of articles in refereed journals not listed in ISI database during 1999-2002.

Table 7 shows that mean points for books among faculty members in the field of Social Science was 14.7 in the period under study. A closer look at the data, in Figure 12 shows that about 35% of faculty members at the field of Social Science published a book in the period 1999 to 2002. Approximately 14% co-authored a book, while a little more than 20% published one book or more.

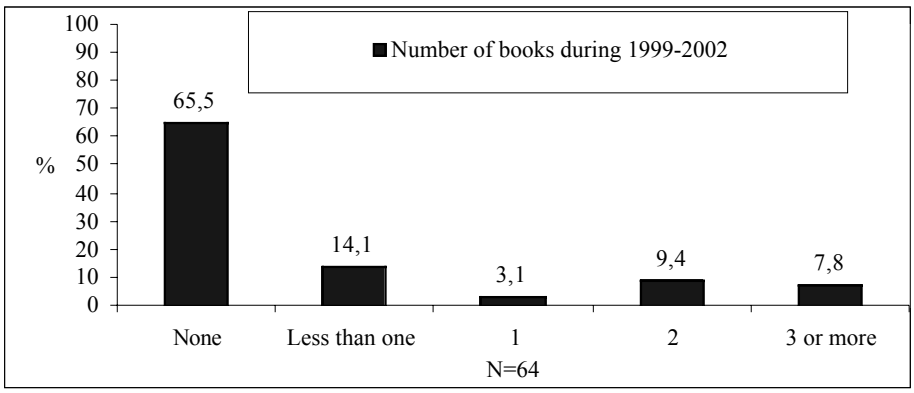

Figure 12. Field of Social Science, number of books during 1999-2002.

Finally Table 7 also shows mean points for book chapters (13.1), conference proceedings (10.8) and plenary lectures at international conferences or key note speeches (2.1) for the faculty members at the field of Social Science while about 9% wrote one book chapter in the period under study.

The field of Humanities

The field of Humanities includes the Faculty of Theology and the Faculty of Philosophy. The data on the field of Humanities is based on information on 68 faculty members.

Figure 13 shows information on number of research points for faculty in the field of Humanities in the years 1999 to 2002. Mean research points in the four year period

are 103.7, while the median is 95. The first quartile of the faculty gets about 40.7 research points or less in the four year period, while 75% get approximately 157 points or less. The top quartile within the field of Humanities spans 158 to 320.5 research points.

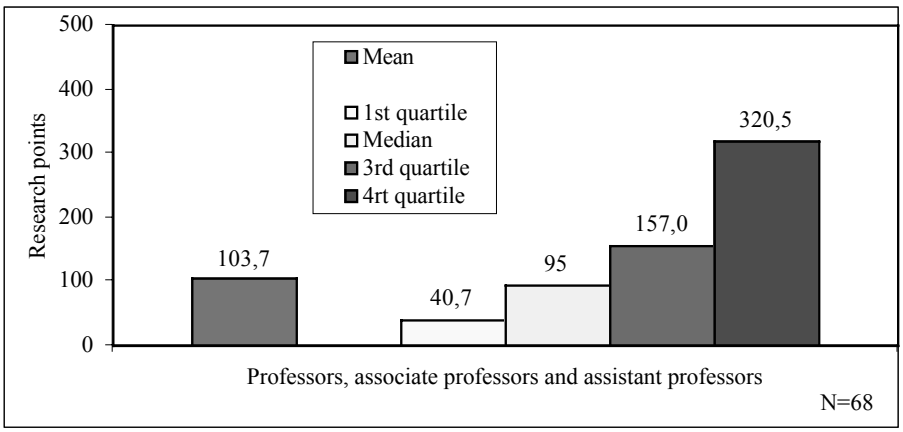

Figure 13. Research points among faculty at the field of Humanities in 1999 to 2002.

Within the field of Humanities, the distribution of research scores is greater among the associate and assistant professors than among the professors, as shown in Figure 14. But on average professors get more points than assistant professors and associate professors. The mean research points in that group are approximately 84.8, where the first quartile gets about 32.5 points or less and the fourth quartile about 137 to 320 points. Professors within the field of Humanities get approximately 125 mean research points. The first quartile among professors gets about 59 points or less and the fourth quartile about 197 to 260 points. It can be pointed out here that one faculty member in the group of associate and assistant professors got more than 200 research points during the four year period under study but among professors seven faculty members in the field of Humanities got more than 200 research points.

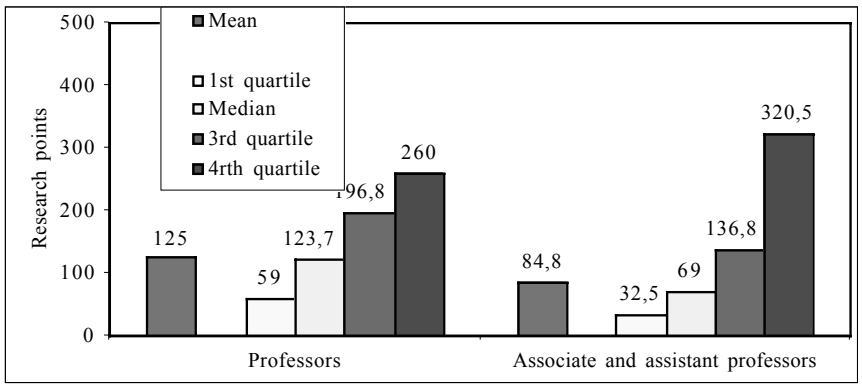

Figure 14. Research points among professors, associate professors and assistant professors within the field of Humanities in 1999 to 2002.

According to interviews a number of researchers in the Humanities seem to dislike the use of journal publication indices. They argue that, as books are their main outputs, the use of journal publications as measures of scholarly performance are inadequate. It comes as no surprise that international journals are not an important publication venue for faculty within the field of Humanities at the University of Iceland. Faculty members in the field of Humanities got 2.8 points for publications in internationally refereed journals in the period under study (see table 8). In Figure 15 we see that about 12% of faculty members published an article in an internationally refereed journal, listed in the ISI database, in the period from 1999 to 2002. About 1.5% co-authored an article, 4.4% published one article in the period under study and approximately 6% published two to three articles.

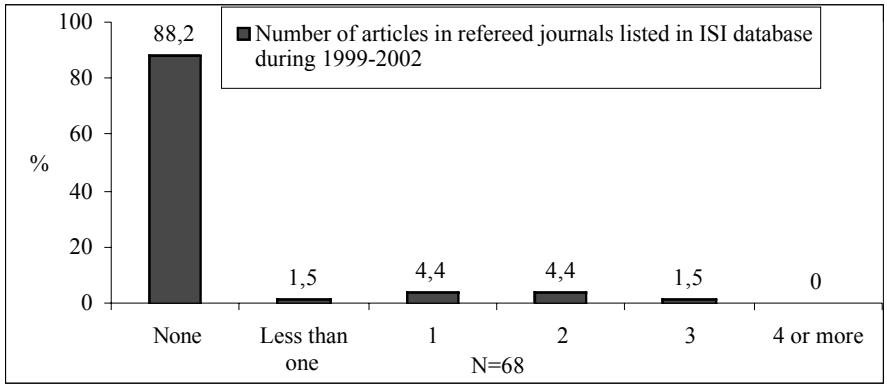

Figure 15. Field of Humanities, number of articles in refereed journals listed in ISI database during 1999-2002.

Table 8 shows that faculty members within the field of Humanities got 18.4 mean points for articles in refereed journals that are not listed in the ISI databases. In Figure 14 we see that approximately 69% of the faculty members published articles in refereed journals that are not listed in the ISI data base, in the four year period. Journals included in this category within the field of Humanities are for example, *Íslenskt mál, Saga* or *Skáldskaparmál.* Approximately a quartile of faculty members within the field of Humanities published four or more articles in non-ISI refereed journals in the four year period; which corresponds to one article per year. Another quartile published two to three articles in non-ISI refereed journals in the four year period and about 18% published one article during that time.

Table 8. Points for bibliometric contributions for professors, associate professors and assistant professors in the field of Humanities[64] in years 1999-2002 (N=68).

Bibliometric criteria	Sum	Mean	Median	Std	Range
Articles in refereed journals listed in ISI database	189	2.8	0	8.3	0-39
Articles in refereed journals not listed in ISI database	1252	18.4	12.5	17.5	0-60
Books	1371	20.2	0	26.7	0-110
Book chapters	1007	14.8	10	18.2	0-80
Papers in conference proceedings	450	6.6	0	10.6	0-47.5
Scientific reports or memoranda	814	12.0	7.0	13.7	0-56
Reviews in academic publications	56	0.8	0	1.6	0-7
Plenary lectures at international conferences or keynote addresses at conferences	196	2.9	0	5.9	0-20
Lectures at scientific conferences	1010	14.9	12.0	13.4	0-56
Lectures for the academic community	154	2.3	1	2.7	0-13
Editors of academic journals and academic books	208	3.1	0	4.5	0-20
Members of editorial boards of academic journals and academic books	152	2.2	0	4.6	0-20

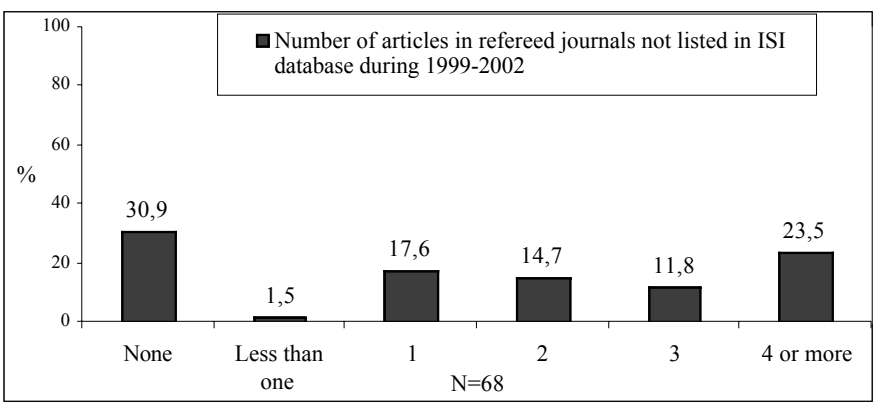

Figure 16. Field of Humanities, number of articles in refereed journals not listed in ISI database during 1999-2002.

Table 8 shows that mean points for books among faculty members in the field of Humanities was 20.2 in the period under study. A closer look at the data, in Figure 17 shows that approximately 47% of faculty members in the field of Humanities at the University of Iceland published a book in the period 1999 to 2002. About 15% co-authored a book with colleagues, approximately 10% published one book and almost 19% published two books in the four year period. Almost 3% of faculty members in the field published three or more books in the period under study.

[64] The field of Humanities includes the Faculty of Theology and the Faculty of Philosophy.

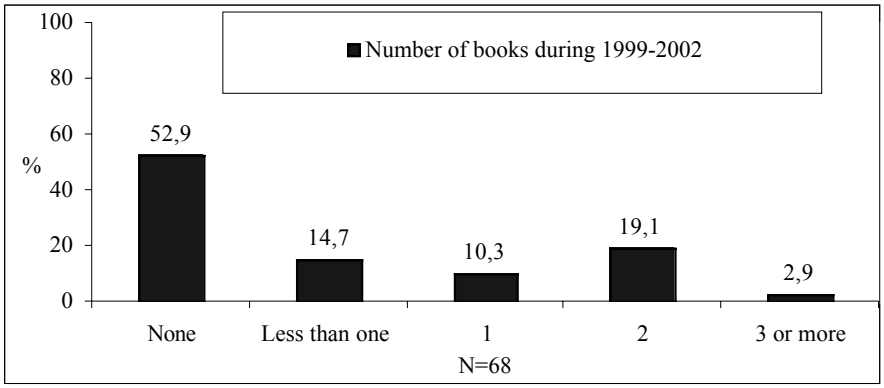

Figure 17. Field of Humanities, number of books during 1999-2002.

Among other information Table 8 shows mean points for book chapters (14.8), conference proceedings (16.6) and plenary lectures at international conferences or keynote speeches (2.9) for the faculty members in the field of Humanities.

The field of Health Science

The field of Health Science includes the Faculty of Medicine, the Faculty of Nursing, the Faculty of Odontology and the Faculty of Pharmacy. The data on the field of Health Sciences is based on information on 60 faculty members. Figure 18 shows mean research scores and their distribution into quartiles among faculty members in the years 1999 to 2002. Mean research points in the four year period is 78.3 while the median is 51.9. The first quartile of the faculty gets 22.5 points or less in the four year period, while 75% get approximately 109 points or less. As before the distribution is also greatest in the fourth quartile or from 109 points to 480 points.

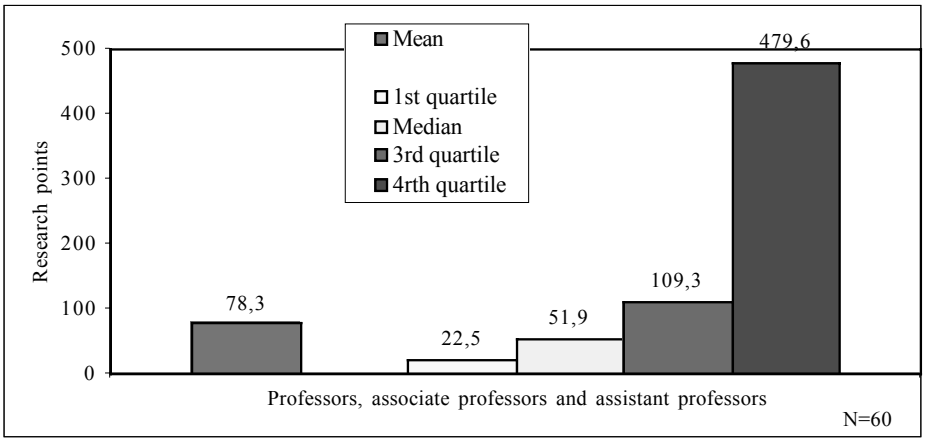

Figure 18. Research points among faculty in the field of Health Science in 1999 to 2002.

It is important to note that in the Health Science there are large variations in points between faculties. Pharmacy researchers have a mean of over 200 points for the four years under study. Mean points in the Faculty of Medical Sciences and Nursing are considerably higher than those in the Faculty of Odontology and Physiotherapy.

Figure 19 shows mean research points and distribution of points into quartiles, separately among professors, associate professors and assistant professors. Within the field of Health Sciences, professors are more productive researchers than the associate and assistant professors. On average professors within the field of Health Science got 105 research points in the four year period under study. The mean for associate and assistant professors for the same period was 52 research points. It may be pointed out that a quartile of associate and assistant professors got only 6 research points during this period. Looking at those who got the most research points within the field, two professors got more than 200 research points and one of the associate and assistant professors got 200 research points or more.

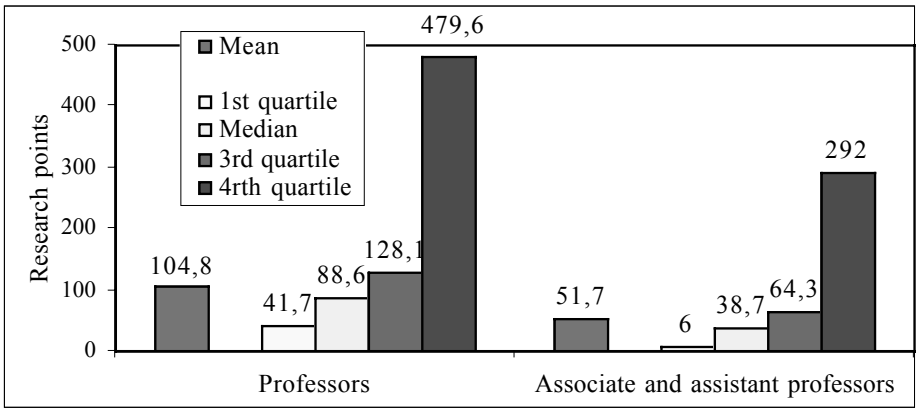

Figure 19. Research points among professors, associate professors and assistant professors in the field of Health Science in 1999 to 2002.

Table 9 shows points for bibliometric contributions for professors, associate and assistant professors in the field of Health Science in years 1999 to 2002. The table reveals that faculty members in the field of Health Science got 25.8 mean points for publishing in internationally refereed journals during that time. Figure 20 shows that a little more than one fifth of the faculty in the field of Health Science had a publication in an international journal, listed in the ISI database, in the period 1999 to 2002. A little less than one fourth of faculty members were co-authors with colleagues on a publication, while about 12% of faculty members published one article in the period under study. About 30% of faculty members published two to three articles in the period under study and 13% published four or more articles in the period.

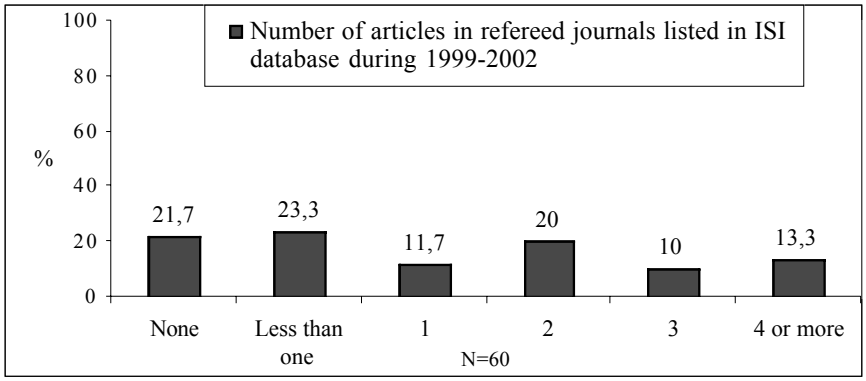

Figure 20. Field of Health Science, number of articles in refereed journals listed in ISI database during 1999-2002.

The results shown in Table 9 furthermore reveal that on average faculty members got 9.4 research points in the years 1999-2002 for articles in refereed journals not listed in ISI database.

Table 9. Points for bibliometric contributions for professors, associate professors and assistant professors in the field of Health Science[65] at the University of Iceland in years 1999-2002 (N=60).

Bibliometric criteria	Sum	Mean	Median	Std	Range
Articles in refereed journals listed in ISI database	1549	25.8	15.0	33.7	0-183
Articles in refereed journals not listed in ISI database	565	9.4	0	13.8	0-62.5
Books	30	0.5	0	2.2	0-12
Book chapters	134	2.2	0	8.2	0-52.5
Papers in conference proceedings	266	4.4	0	11.6	0-62.5
Scientific reports or memoranda	407	6.8	4.9	6.3	0-29
Reviews in academic publications	3.0	0	0	0.3	0-2
Plenary lectures at international conferences or keynote addresses at conferences	145	2.4	0	5.4	0-24
Lectures at scientific conferences	750	12.5	8.0	23.4	0-170.5
Lectures for the academic community	122	2.0	1	2.5	0-11.5
Editors of academic journals and academic books	55	0.9	0	2.8	0-15
Members of editorial boards of academic journals and academic books	128	2.1	0	4.2	0-24

Looking at Figure 21 it can be seen that approximately 48% of faculty members in the field of Health Science, published articles in refereed journals that are not listed in the ISI data base, in 1999 to 2002. Journals in the field of Health Science included in

[65] The field of Health Science includes the Faculty of Medicine, the Faculty of Nursing, the Faculty of Odontology and the Faculty of Pharmacy.

this category are for example Icelandic journals such as *Læknablaðið*. Approximately 17% of faculty members co-authored a publication with colleagues. About 15% of faculty members published one or two articles in non-ISI refereed journals in the four year period and about 17% published three articles or more in non-ISI refereed journals in the period 1999 to 2002.

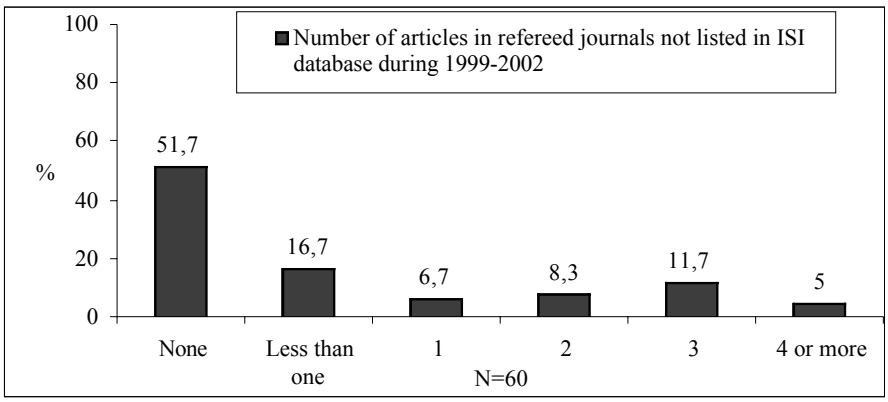

Figure 21. Field of Health Science, number of articles in refereed journals not listed in ISI database during 1999-2002.

Table 9 shows that books are not an important publishing venue for scholars within the field of Health Science. On average faculty members within the field got only 0.5 research points for books during the period under study. Figure 22 displays that approximately only 5% of the faculty in the field of Health Science authored or co-authored a book in the period 1999 to 2002.

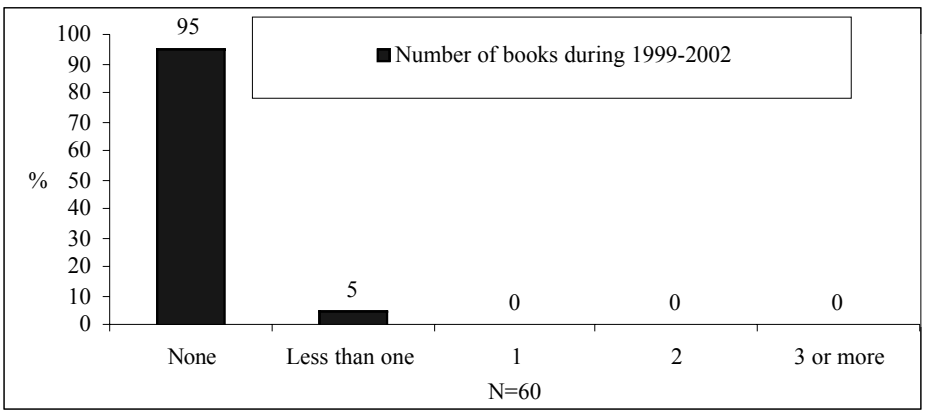

Figure 22. Field of Health Sciences, number of books during 1999-2002.

Similarly only a small proportion of faculty members published book chapters in the four year period under study. On average faculty members got 2.2 research points for book chapters during that time (Table 9). About two percent of faculty members co-published a book chapter in the period under study, while 10% published one chapter or more in the years 1999 to 2002 (not shown).

Furthermore Table 9 shows mean research points for other measures of bibliometric performances for faculty members within the field of Health Science, such as papers in conference proceedings (4.4) and plenary lectures at international conferences or keynote addresses at conferences (2.4).

The field of Science and Engineering

The field of Science and Engineering includes the Faculty of Science and the Faculty of Engineering. The data on the field of Science and Engineering is based on information on 86 faculty members. Figure 23 shows information on measures of central tendency and variability of research points for faculty members within the field in the years 1999 to 2002. Mean research points in the four year period is 89.5, while the median is 76.9. The first quartile of the faculty gets 31 points or less in the four year period, while 75% get approximately 135 points or less. In the top rank, that is the fourth quartile, faculty members get 135 to 375 points during this four year period.

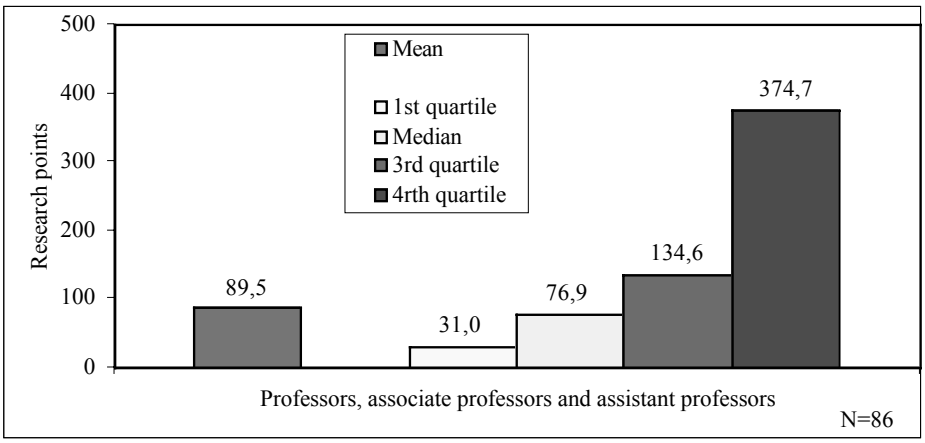

Figure 23. Research points among faculty in the field of Science and Engineering in 1999 to 2002.

Looking at research points for professors and associate and assistant professors separately, figure 24 shows that within the field of Science and Engineering professors are the most productive researchers. On average professors within the field got 104 research points in the four year period under study while the mean for the associate and assistant professors for the same period was 62 research points. The bottom quartile of associate and assistant professors however received only 9 research points or less per faculty member during this time. Further looking at those who got the most research points within the field, six professors got more than 200 research points but none of the associate and assistant professors.

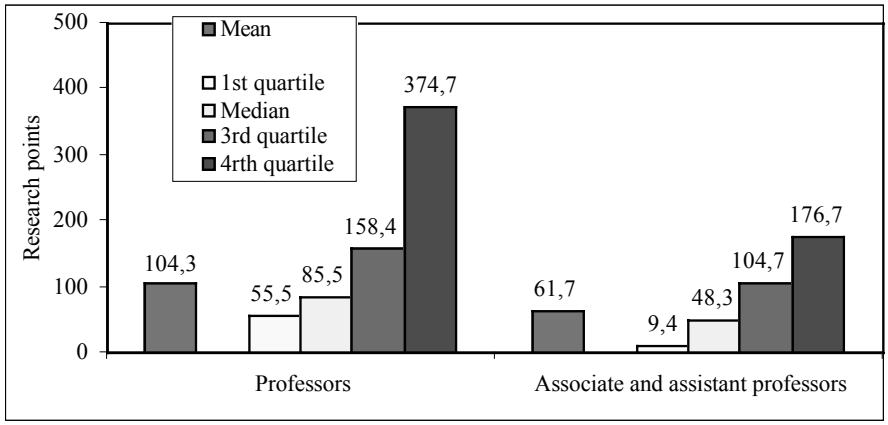

Figure 24. Research points among professors, associate professors and assistant professors in the field of Science and Engineering in 1999 to 2002.

Table 10 reveals information on points for different scholarly activities among faculty in the field of Science and Engineering.

Table 10. Points for bibliometric contributions for professors, associate professors and assistant professors in the field of Science and Engineering[66] in years 1999-2002 (N=86).

Bibliometric criteria	Sum	Mean	Median	Std	Range
Articles in refereed journals listed in ISI database	2031	23.6	10.3	33.5	0-169
Articles in refereed journals not listed in ISI database	808	9.4	6.8	11.7	0-54
Books	136	1.6	0	9.4	0-80
Book chapters	298	3.5	0	7.8	0-53.5
Papers in conference proceedings	1474	17.1	1.1	30.5	0-153
Scientific reports or memoranda	833	9.7	7.1	9.1	0-40
Reviews in academic publications	4.0	0	0	0.26	0-2
Plenary lectures at international conferences or keynote addresses at conferences	350	4.1	0	8.2	0-40
Lectures at scientific conferences	952	11.1	6.5	12.6	0-63
Lectures for the academic community	138	1.6	1.0	2.3	0-9
Editors of academic journals and academic books	76	0.9	0	2.6	0-16.5
Members of editorial boards of academic journals and academic books	99	1.2	0	2.5	0-10

Faculty members in the field of Science and Engineering got on average 23.6 points for publishing in internationally refereed journals during the period under study. Figure 25 shows that about 62% of faculty members in the field of Science and Engineering published an article in an international journal, listed in the ISI database, in the period 1999 to 2002. Approximately 14% were co-authors with colleagues on a

[66] The field of Science and Engineering includes the Faculty of Engineering and the Faculty of Science.

publication, but did not attain 15 points which are the points given for one published article in an internationally refereed journal. About a quartile of faculty members published one or two articles during 1999 to 2002 and approximately 22% published three articles or more during that period of time.

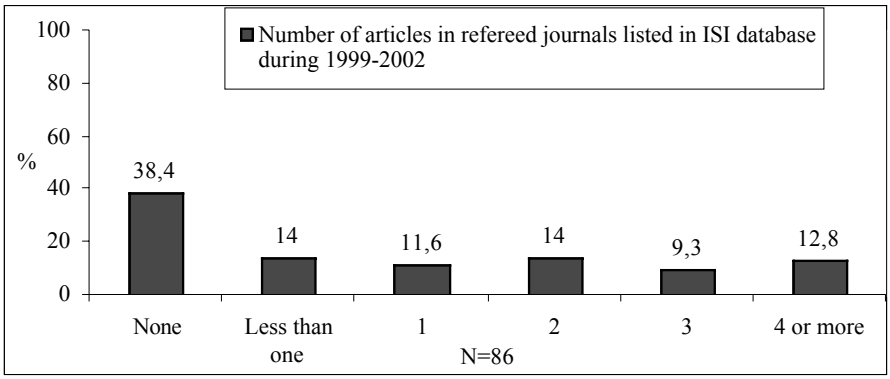

Figure 25. Field of Science and Engineering, number of articles in refereed journals listed in ISI database during 1999-2002.

In Table 10 it is demonstrated that most of the research points that faculty members within the field of Science and Engineering at the University of Iceland got in 1999-2002 was for articles in refereed journals listed in ISI database (or total 2031 points, mean 23.6). Second are research points for papers in conference proceedings (total 1474 points, mean 17.1) and third scores for lectures at scientific conferences (total 952 points, mean 11,1).

Mean research points for articles in refereed journals not listed in ISI database among faculty members within the field of Science and Engineering in years 1999 to 2002 is 9.4 (see table 10). Figure 26 reveals that approximately 58% of faculty members in the field of Science and Engineering published articles in refereed journals that are not listed in the ISI (Institute for Scientific Information) data base, in 1999 to 2002. Journals in the field of Science and Engineering, included in this category are for example Icelandic journals such as *Jökull*. Approximately 13% of faculty members co-authored a publication with colleagues. About one fifth of faculty members published one article in non-ISI refereed journals in the four years period and 14% published two articles. About 12% published three articles or more in non-ISI refereed journals in the period 1999 to 2002.

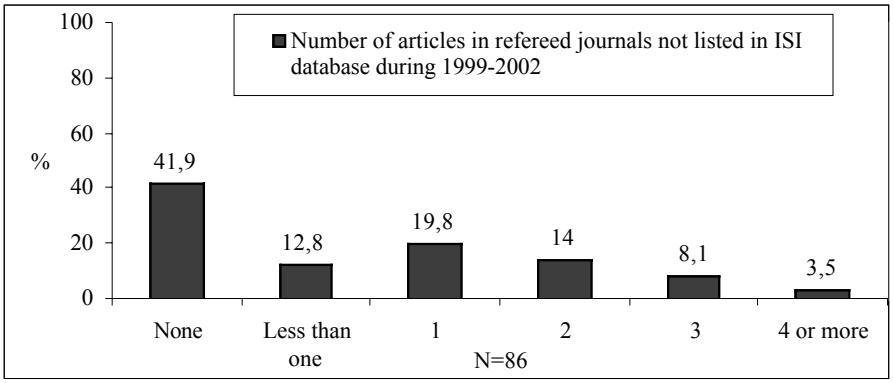

Figure 26. Field of Science and Engineering, number of articles in refereed journals not listed in ISI database during 1999-2002.

As shown in Table 10 books are not an important publishing venue for scholars within the field of Science and Engineering. Thus the average research points for books in this four year period among faculty members of the field is low, or 1.6 points. This equals that 5% of faculty members published a book in the period 1999 to 2002 (Figure 27).

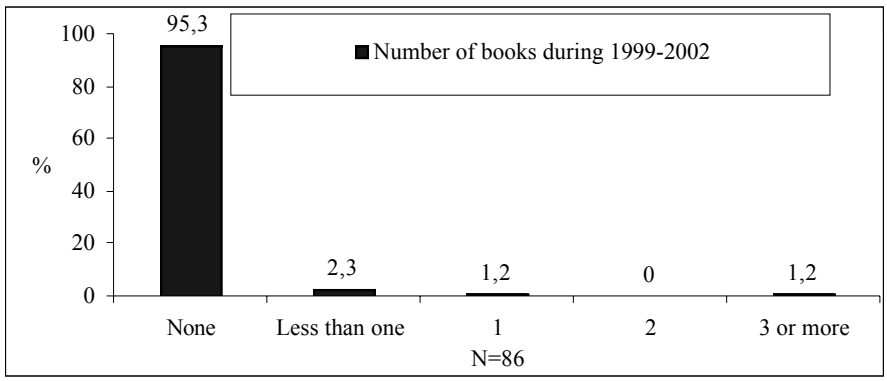

Figure 27. Field of Science and Engineering, number of books during 1999-2002.

Mean research points for book chapters among the faculty was 3.5. Approximately 15% in the field co-authored a chapter, while approximately another 15% wrote one book chapter or more in the period under study (not shown).

Collaboration within Iceland

Increased cooperation between universities on the one hand and institutes and companies on the other hand, is one of the main characteristics of the organizational change in science that has taken place in the last two decades[67]. Good relationships

[67] Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., and Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage Publications.

among research institutions, universities, and corporations are viewed as a fundamental premise for the continuing development of research work in modern society[68]. The difference between basic research and applied research is growing ever smaller and an increasing amount of basic research takes place in corporations. It is therefore important to strengthen the collaboration among these parties as much as possible. Similarly, inter-disciplinarity within universities has increased as the rapid accumulation of knowledge now calls for teams rather than individual researchers to solve scholarly issues that require different abilities and knowledge of disparate academic fields.

Collaboration between the University of Iceland and others

As mentioned above scholars at the University of Iceland and related institutions were the authors of approximately 80% of all articles that were written by Icelandic authors in the period 1999 to 2002. Around 69% of all articles were written by authors from the university only and 11% were co-authored with researchers from other non university related institutions. Scholars at other universities were the authors of 3% of articles. About one fifth of papers by authors at other universities were co-authored with faculty members at the University of Iceland.

The Science Policy of the University of Iceland states that research at the university should be carried out in collaboration with other universities, institutes and companies, wherever opportunities and needs arise. Cooperation between the University of Iceland and other universities however is still minimal. About 30% of papers were written by employees of Icelandic institutes devoted to scientific and scholarly work. A little more than one third of those papers were written jointly with scholars at the University of Iceland. DeCode, with a ratio of 4%, had the highest authorship percentage of papers written at research institutes outside the University of Iceland.

Collaboration between fields within the University of Iceland

A perusal of data from the *Web of Science* database, reveals that, during the period from 1999-2002, approximately one tenth of articles at the University of Iceland were written in cooperation between departments or subject fields. Approximately 6% of articles were co-authored by scholars across departments, but within the same subject field. Most of those articles were written jointly by scholars within the field of Health Sciences. The second main collaboration was within the field of Science and Engineering. Approximately 3% of articles were written jointly by authors from different subject fields. Most of those articles were written by scholars from the field of Health Sciences and the field of Science and Engineering. These findings are in line

[68] Inga Dóra Sigfúsdóttir og Þórólfur Þórlindsson (2000). *Grunnvísindi á Íslandi*, Menntamálaráðuneytið, Reykjavík.

with studies that have shown that co-authorship is much more common in the fields of health and Natural science than in the Social sciences or Humanities[69].

In general little evidence exists in the bibliometric data of cooperation between departments and subject fields within the University of Iceland. The University Science policy states that there is a need to increase interdisciplinary work and the diversity of research carried out at the university. It is clear that there is a need for more cooperation. In the attitude survey only 25% of professors, associate and assistant professors felt that cooperation between departments was generally good[70]. About 23% of participants were undecided on this topic.

[69] Wendt, K., Slipersæter, S., and Aksnes, D.W. (2003). Internationalisation of Research in: Gornitzka, Å., Gulbrandsen, M., and Trondal, J. (eds). Internationalisation of Research and Higher Education – Emerging Patterns of Transformation, Report 2/2003.

[70] The results in the fields where the response rate was above 60% are specifically denoted here, i.e. the field of Social Sciences and Humanities (together with response rate of 70.4%). A comparable ratio of those professors, associate professors and assistant professors, participating in the survey, in the field of Health Sciences and the field of Science and Engineering was 37% and 20% were undecided.

RESEARCH ADMINISTRATION AND FUNDING

Operational framework for research

Within the 1999 Act, the *faculties* are defined as being the basic units of the University, within which education, research and administration are carried out. In Article 9 it is stated that:

> The Faculties are autonomous in their own affairs, within the limits set by common University rules. Regular assessment shall be made of Faculties' activities in accordance with the provisions of applicable Acts and Rules.

The universities are "independent national institutions" and the faculties are "autonomous in their own affairs". The operational framework is provided by the passing of further acts and rules. The Minister lays down the general rules and the university itself lays down the common university rules. The University is divided into 11 faculties, 43 research centres/groups/institutes and several service departments. The Department of Research Affairs (rannsóknasvið, DOR) is responsible for a wide range of operational duties within the University. It is responsible for all common matters regarding research within the university, including advice to academic staff and institutes. It is expected to encourage cooperation between academic departments and research institutes. The Science Committee (vísindanefnd) is one of the working committees of the University Council (háskólaráð).

One of the tasks of the DOR is to collect and process information from academic staff on their research activities and publications which is submitted once a year and assessed according to the productivity assessment scheme introduced several years ago (discussed further below). The Science committee is responsible for making decisions on grants from the Research Fund; three sub-committees evaluate all applications. Applications for sabbatical leave are sent to the DOR.

Distribution of students across departments

Here we present data on the number of students at the University of Iceland in order to place the research funding and performance in context. The number of "full-time" equivalent students at universities in 2002 and 2003 are as in Table 11.

Table 11. Number of university students (full-time equivalent).

Year	University of Iceland	%	Other universities in Iceland	Total
2002	4699	54%	3990	8689
2003	5255	53%	4750	10005

In Figure 28 it can be seen that the proportion of full-time students as part of the total number enrolled (in October each year) has been decreasing over the last few years, from 69% in 1997 to 59% in 2003[71]. It had been agreed that Government funds for the year 2003 would be for 4950 students but in fact there were 5275 full-time equivalent students that year. It was estimated that funds would be provided for 5200 full-time students for the year 2003-2004 but the number enrolled in October 2003 was 5329. Thus over the last few years the number of students enrolled has consistently been higher than the funds that have been provided.

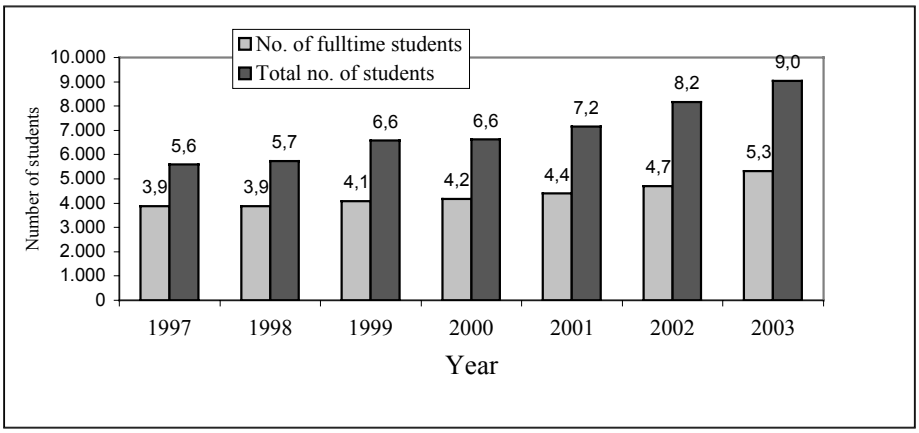

Figure 28. Full-time students equivalent (funded by government) and total number of students enrolled at the University of Iceland.

In order to place the activities of researchers and the relative strengths of the different academic fields in context we show the number of students enrolled in the different departments and the number graduating from different departments for the period 1999-2000 in figures 29 and 30[72].

[71] Starfs- og fjárhagsáætlun 2004.
[72] Starfs- og fjárhagsáætlun 2004, p. 21.

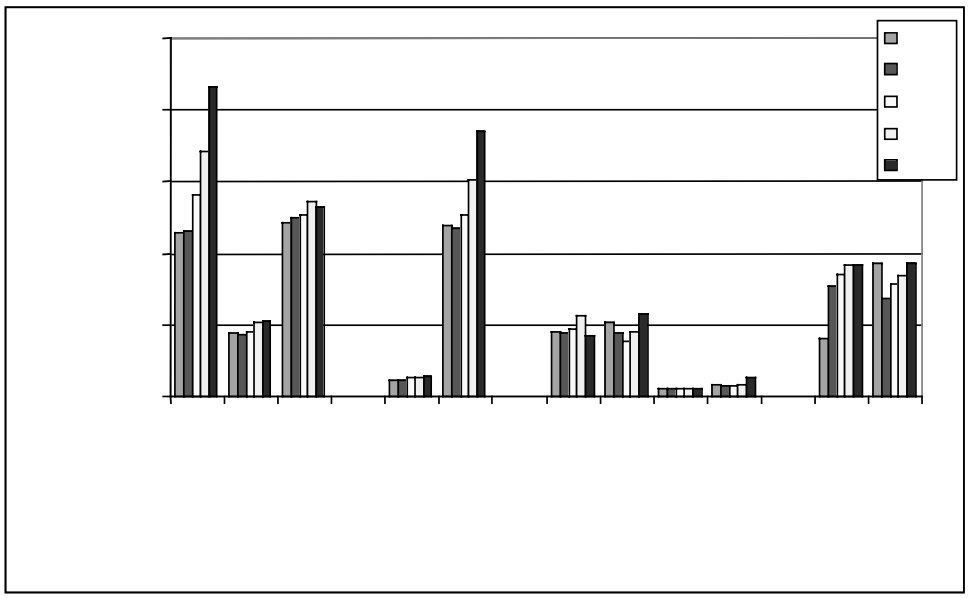

Figure 29. Number of students enrolled according to department 1999-2002[73]

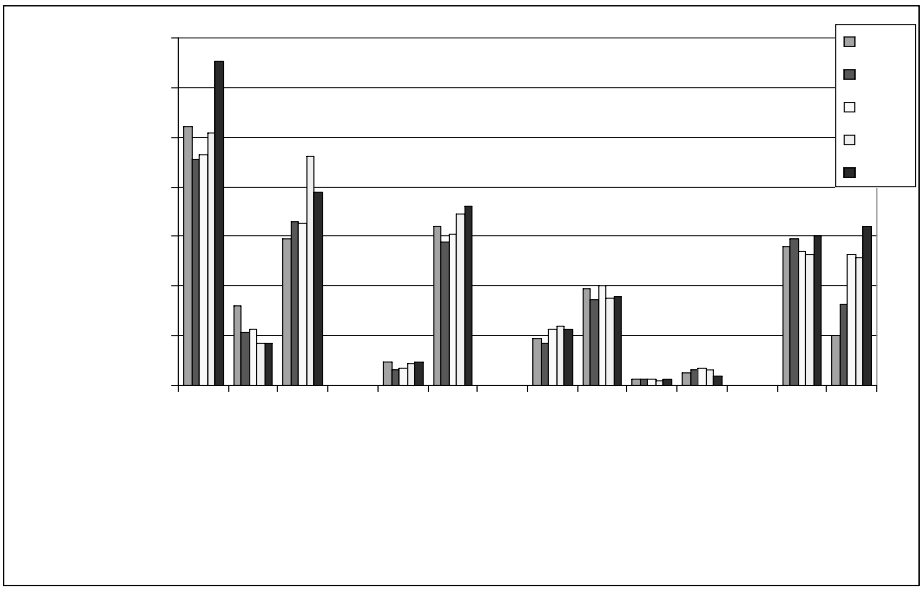

Figure 30. Number of students graduating from different departments 1999-2002[74]

In the chapter on research performance the analysis was divided into four fields: Social Science, Humanities, Health Science and Science and Engineering. The

[73] Starfs- og fjárhagsáætlun 2004, p. 21.
[74] Starfs- og fjárhagsáætlun 2004, p. 21.

numbers of students enrolled and graduating from these four fields are shown in Tables 12 and 13.

Table 12. Percentage of students enrolled at the University of Iceland according to field[75].

	1999	2000	2001	2002	2003
Social Science	43%	43%	44%	44%	44%
Humanities	20%	19%	20%	20%	22%
Health Science	17%	15%	14%	14%	13%
Engineering and Science	20%	22%	23%	22%	20%

Table 13. Percentage of students graduating from the University of Iceland according to field[76].

	1999	2000	2001	2002	2003
Social Science	47%	45%	42%	46%	45%
Humanities	18%	16%	16%	17%	16%
Health Science	16%	15%	17%	15%	13%
Engineering and Science	19%	23%	25%	23%	25%

Research funding at the University of Iceland

Institutional level

In this section we will consider the funds which are available for research at the University of Iceland and the extent to which funding is associated with performance of university researchers.

According to the agreement on a framework for the development of research activities between the University of Iceland and the Ministry of Education, general funds for research and other activities of the University of Iceland are 1269 m.kr. in 2004. It is assumed that the annual contribution during the period of agreement will be at least that amount and will be subject to changes in value according to general indicators. The general funds for research are expected among other things to finance salary contributions because of research (40%), sabbatical leave, contributions to the assessment of productivity fund, overall administration of research, facilities used for research, contributions to the supervision of research training, direct costs of research, participation in competitions for research funds and to provide for basic facilities and investments which are not usually provided for by competitive grants.

[75] Starfs- og fjárhagsáætlun 2004, p. 21.
[76] Starfs- og fjárhagsáætlun 2004, p. 21.

In making decisions on the distribution of funds to research for the years 2004, 2005 and 2006 the University will take note of the following factors:

1. Research points, according to the assessment of productivity scheme.
2. Number of students graduating with a master's degree.
3. Number of students graduating with a doctoral degree.
4. Amounts received from international research funds.
5. Amounts received from national research funds.

According to the research agreement, the ministry takes cognizance of the assessment of productivity scheme used by the University of Iceland, funds permitting. The ministry also monitors the development and improvement of assessment methods during the period under agreement. In Figure 31 we see the pattern of funding over the last few years with increasing funds going into teaching and less going into research.

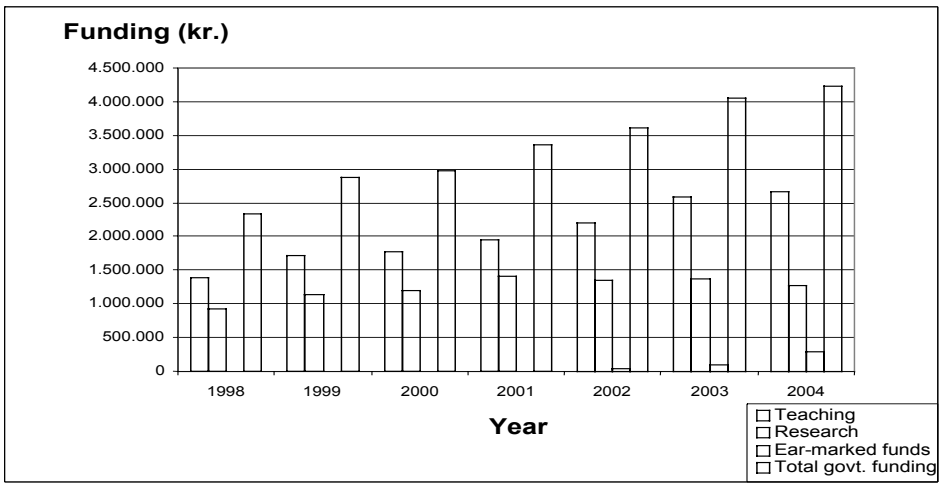

Figure 31. Government funding for teaching and research at the University of Iceland[77]

Now we consider the distribution of funds (income and expenditure) spent in the university sector in the years 2001 and 2002. All figures were made available to us by the Ministry of Education.

In Table 14 we consider the distribution *between* universities in Iceland, i.e. how much is allocated and spent in the University of Iceland as a total of all universities in Iceland. In Table 15 we consider the distribution of funds within the University of Iceland i.e. allocations to teaching, research, administration and other activities. All other universities are grouped together in order to provide a measure of comparison. These universities are both public and private[78].

In 2001 57% of all government funding to universities in Iceland went to the University of Iceland and in 2002 this Figure dropped to 52% (table 14). In 2001 52%

[77] Figures from the Ministry of Education.
[78] Bifröst, HA, HR, KHÍ, Listaháskóli, Tækniháskóli. Institutes at UI are not included.

of all funds spent on university teaching was spent by the University of Iceland and this rose to 57% in 2002. In 2001 82% of all funds for research spent by universities were spent by the University of Iceland, with this figure dropping to 79% in 2002.

The University of Iceland has a smaller proportion of all income coming from student fees than the other universities combined (35% of the total in 2001 and 31% in 2002). At the same time less money is spent in the university on university administration than in the other universities (44% of the total in 2001 and 40% in 2002).

We can sum up by saying that the university received a little more than half of all national funding for universities. This and other funding was used to pay for more than half of all teaching in 2001 (52%) and in 2002 (57%), proportions which are comparable to the number of full-time equivalent students at the university compared with other universities. Some economy in administration is evident in the university but this is one institution accounting for about half the students in Iceland, while all other students are enrolled at six different universities. About four-fifths of all funds that went into university research are attributable to the University of Iceland (82% in 2001 and 79% in 2002) (table 14).

Table 14. Distribution of total funds between universities[79]

INCOME	University of Iceland		Other universities		Total	
2001						
National funds	3392	57%	2591	43%	5983	10
Other funds, incl. research grants	1354	87%	211	13%	1565	10
Registration fees	155	35%	284	65%	439	10
Other income	55	61%	35	39%	90	10
Total	**4956**	**61%**	**3121**	**39%**	**8077**	**10**
2002						
National funds	3602	52%	3278	48%	6880	10
Other funds, incl. research grants	1319	84%	253	16%	1572	10
Registration fees	213	31%	483	69%	696	10
Other income	78	44%	99	56%	177	10
Total	**5212**	**56%**	**4113**	**44%**	**9325**	**10**
EXPENDITURE	**University of Iceland**		**Other universities**		**Total**	
2001						
Teaching	1710	52%	1557	48%	3267	10
Research	2337	82%	496	18%	2833	10
Administration	596	44%	750	56%	1346	10
Facilities	388	44%	499	56%	887	10
Other expenses		0%	47	100%	47	10
Total	**5030**	**60%**	**3349**	**40%**	**8379**	**10**
Teaching, research and admin.	*4642*	*62%*	*2803*	*38%*	*7446*	*10*
2002						
Teaching	2352	57%	1762	43%	4114	10
Research	2318	79%	623	21%	2941	10
Administration	662	40%	990	60%	1652	10
Facilities	448	33%	892	67%	1340	10
Other expenses		0%	66	100%	66	10
Total	**5780**	**57%**	**4333**	**43%**	**10113**	**10**
Teaching, research and admin.	*5332*	*61%*	*3375*	*39%*	*8707*	*10*

The University of Iceland receives about two-thirds of its operational revenue from the Ministry of Education and about a third from other sources (figure 32)[80].

[79] Figures from the Ministry of Education.
[80] http://www.hi.is/pub/rann/stadtolur/fjarmal/tekjur_88_02.htm

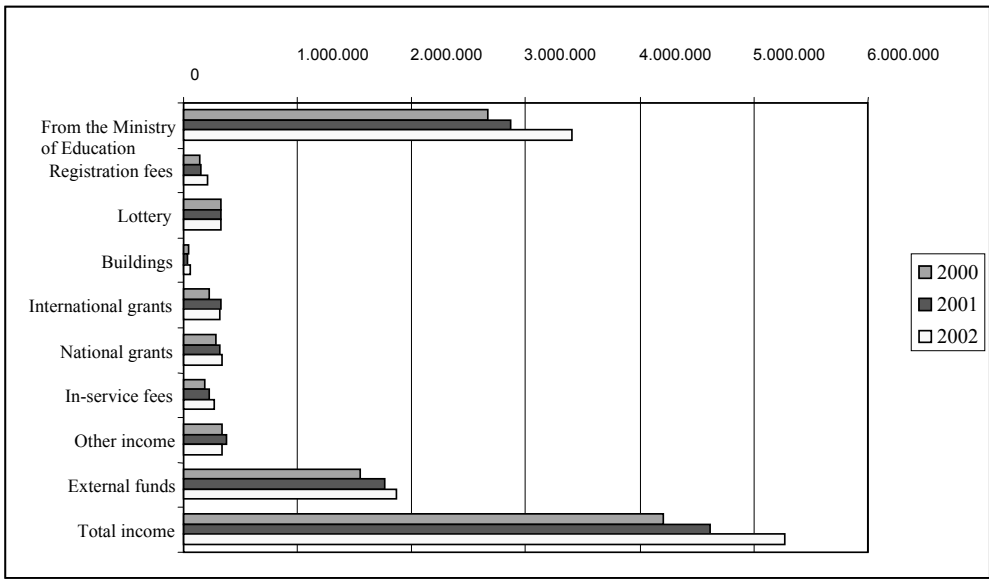

Figure 32. Sources of income at the University of Iceland.

In Table 15 we see that national funding accounts for almost 70% of all funds available to the University of Iceland but teaching, research and administration accounts for 92% of funds spent. The national funds are divided by the university into teaching and research allocations in accordance with the terms of the salary agreements with teacher unions. Teaching and administration accounts for 57% of salaries and research about 43%. The national funds are supplemented by other income, which includes national and international research grants, of about 25-27%.

Some economy was achieved in administration in relative terms but the amount spent on teaching went from 34% to 41%, an increase in actual terms of over 600 m.kr., much of which can be attributed to increases in the salaries of academic staff after the last agreement was reached in 2001.

We turn now to the distribution of funds *within* the university. Both the relative and the actual amount of funds spent on research dropped from 46% (2337 m.kr) in 2001 to 40% (2318 m.kr.) in 2002, of which 1685 m.kr. was allocated from government funds in 2001 and 1691 m.kr. in 2002. In 2003 this amount had dropped to 1358 m.kr. in 2003 and to 1274 m.kr. in 2004. At the same time the amount being allocated to national competitive research funds has been increased by 400 m.kr., of which 100 m.kr. is in the national Research Fund and 200 m.kr. in the Technology Development Fund.

Table 15. Distribution of funds within University of Iceland[81]

INCOME	University of Iceland		Other universities		Total	
2001						
National funds	3392	68%	2591	83%	5983	7
Other funds, incl. research grants	1354	27%	211	7%	1565	1
Registration fees	155	3%	284	9%	439	
Other income	55	1%	35	1%	90	
Total	**4956**	**100%**	**3121**	**100%**	**8077**	**10**
2002						
National funds	3602	69%	3278	48%	6880	7
Other funds, incl. research grants	1319	25%	253	16%	1572	1
Registration fees	213	4%	483	69%	696	
Other income	78	1%	99	56%	177	
Total	**5213**	**100%**	**4113**	**44%**	**9325**	**10**
EXPENDITURE	**University of Iceland**		**Other universities**		**Total**	
2001						
Teaching	1710	34%	1557	46%	3267	3
Research	2337	46%	496	15%	2833	3
Administration	596	12%	750	22%	1346	1
Facilities	388	8%	499	15%	887	1
Other expenses		0%	47	1%	47	
Total	**5030**	**100%**	**3349**	**100%**	**8379**	**10**
Teaching, research and admin.	*4642*	*92%*	*2803*	*84%*	*7446*	*8*
2002						
Teaching	2352	41%	1762	41%	4114	4
Research	2318	40%	623	14%	2941	2
Administration	662	11%	990	23%	1652	1
Facilities	448	8%	892	21%	1340	1
Other expenses		0%	66	2%	66	
Total	**5780**	**100%**	**4333**	**100%**	**10113**	**10**
Teaching, research and admin.	*5332*	*92%*	*3375*	*78%*	*8707*	*8*

The distribution of funds between departments and fields for teaching and research for the year 2004 is shown in tables 16 and 17. The budget figures are based on the number of students, the minimum amount of teaching required to serve their needs and the research productivity of the staff.

[81] Figures from the Ministry of Education.

Table 16. Distribution of funds for teaching and research between the four main fields 2004[82].

	Departmental funding 2004	Minimum teaching costs 2004	Enrolled students 2003
Social Sciences	27%	26%	44%
Humanities	16%	18%	22%
Health Sciences	24%	27%	13%
Engineering and science	33%	30%	20%

Table 17. Percentage of total funding allocated to teaching (minimum).

Teaching and research departments	**Departmental funding[83]**	**Minimum teaching costs[84]**	
	2004	**2004**	%
Social Sciences	379.809 kr.	166.384 kr.	44%
Law	98.945 kr.	40.186 kr.	41%
Business and economics	258.740 kr.	104.259 kr.	40%
Theology	44.146 kr.	22.143 kr.	50%
Arts (philosophy)	410.537 kr.	198.779 kr.	48%
Medicine	343.356 kr.	172.227 kr.	50%
Nursing	181.870 kr.	80.783 kr.	44%
Dentistry	81.014 kr.	45.948 kr.	57%
Pharmacy	57.842 kr.	27.884 kr.	48%
Engineering	335.598 kr.	139.217 kr.	41%
Science	578.749 kr.	220.512 kr.	38%
Fields	**2004**	**2004**	
Social Sciences	737.494 kr.	310.829 kr.	42%
Humanities	454.683 kr.	220.922 kr.	49%
Health Sciences	664.082 kr.	326.842 kr.	49%
Engineering and Science	914.347 kr.	359.729 kr.	39%
TOTAL	**2.770.606 kr.**	**1.218.322 kr.**	**44%**

Incentives at the individual level

In order to achieve its objectives the University operates a formal system of performance-based incentives, which form the foundation for decisions on faculty salaries. The rules underlying the annual productivity assessments include rules on teaching, research, and administration with a detailed scheme of the contribution of academic employees to research. The rules are intended to evaluate researchers' contribution and impact at the international and the domestic level. Therefore, they take

[82] Starfs- og fjárhagsáætlun 2004, p. 10, 11 and 13.
[83] Starfs- og fjárhagsáætlun 2004, p. 13.
[84] Starfs- og fjárhagsáætlun 2004, p. 11.

into consideration each researcher's published articles in internationally recognized journals and peer-reviewed Icelandic periodicals, as well as the number of books the scholar has published and the number of citations of that scholar's work, to name just a few points of emphasis. In this way, the rules evaluate Icelandic scientists' contribution to the international arena as being of equal value with their contribution to the furtherance of Icelandic history and culture.

In practice, the basic elements of this system are as follows:

- Every year teachers and specialists inform the university of their research and its findings.
- Publications, writings and other intellectual works are scored by a group of peers. For each publication or intellectual work teachers and researchers obtain research points.
- The evaluation is according to the university's formal research evaluation system. Evaluation of publications is based on the quality of the work and the forum in which they are published.

The outcome of this evaluation has an effect on:

- The future academic advancement,
- Classification into basic wage categories and
- Yearly payments from the University's Research Productivity Fund, which distributes an amount equal to 12% of the total salary costs at the university.

Publishing activity is furthermore one of the chief criteria for allocation from the Research Fund of the University, which supports research projects of teachers and researchers.

Funds to support research

Seven funds support research, instruction and administration, at the University of Iceland[85]. One of these funds, *the University of Iceland Research Fund* is solely targeted at supporting research. In 2004 University of Iceland received 20 m.kr. in addition to the agreement discussed above, intended for the University of Iceland Research Fund. The Ministry also took action to provide for earmarked contributions to the Fund in 2005 and 2006.

As mentioned earlier, the Science committee at the university is responsible for making decisions on grants from the Research Fund; three sub-committees evaluate all applications. The evaluation of applications is based on peer review. The role of the Fund is to encourage research at the University[86]. Assessment of projects is primarily based on the scientific value of the project, with attention being paid to the research activity of the applicant. The Board of the Fund is supposed to ensure that qualified

[85] The funds are listed in appendix V.
[86] Rules for the University of Iceland no. 458/2000

persons provide a professional opinion on all applications by applicants eligible for grants.

Professors, associate professors and assistant professors at the University of Iceland may apply for grants from the fund. Furthermore experts, non-tenured lecturers paid on a salaried basis, scholars and specialists at the University also may apply for grants from the fund. Experts, scholars and specialists must have research as their principal employment. Furthermore, they may be awarded grants, provided the institute has agreed to direct an agreed portion of its income from service projects to the fund. Grants may also be awarded to specialists of other institutes which have concluded a special agreement with the University of Iceland concerning contributions to the University of Iceland Research Fund. The University Council determines the annual allocations to the research fund.

As a part of this appraisal an analysis was conducted of the grants to professors, associate professors and assistant professors for the year 2000[87]. In 2000 the total number of grant applications was 197, 136 men and 60 women[88]. Information on professors, associate professors and assistant professors, 128 individuals in total,[89] was processed. More than 80% of the professors, associate professors and assistant professors who applied for a grant in 2000 received one. The analysis indicates a connection between research performance and a dispensation from the research fund. The average number of research points among those who received a grant in 2000, was 35 points the year before. On the other hand, the average number of research points among those who did not receive a grant in 2000 was 25. The proportion of applicants with 65 research points or more was 14% for those who received a grant. None of those who did not receive a grant had 65 points or more. Furthermore the correlation between the grant amount and total research points is positive and relatively strong ($r = .33$). This means that the more active in research the person is the higher the grant he/she received from the research fund. Yet this correlation indicates that other factors are important in the decision making for dispensation from the fund. Thus the amount of research points in 1999 only explains around 11% of the dispensation of grants in 2000. Accordingly, it can be pointed out that among those who did not receive a grant were active researchers. As an example, 9% of the applicants who did not receive a grant had around 60 research points in 1999. Furthermore, 10% of the applicants who did receive a grant in 2000 had 10 research points or less in 1999. These grants went to newly employed scientists.

[87] The year 2000 was randomly selected from the years 1999 til 2002, which were used as reference periods in this analysis.
[88] One of the applicants was an institution (not an individual)
[89] The total number of professors, associate professors and assistant professors was 144, information on research acctivities was lacking for 16 individuals.

Examining the awarded grants by gender it appears that approximately 83% of the women and 82% of the men who applied for grants in 2000, received one. Gender does not appear to explain the probability of a dispensation from the fund.

CONCLUSIONS AND RECOMMENDATIONS

This evaluation has been carried out at the request of the Minister of Education, Science and Culture. The Universities Act of 1998 emphasizes increasing autonomy of higher education institutes in managing financial and human resources. At the same time the Act emphasizes the monitoring role of the Ministry. The evaluation is carried out according to regulations on quality control in higher education, issued by the Ministry of Education, Science and Culture in 1999.

The evaluation provides information on the performance of scholars within ther University of Iceland and on the administration of research and the way in which it is funded. Attempts have been made to place developments and performance in an international context.

We find that there are several issues in the information gathered and its interpretation. One is the way in which the University is mainly funded in terms of its teaching function, but significant demands are made on it as a research institution. Another dilemma is finding a balance between meeting national needs, serving society and researching its history and culture, and being an international university, with demands for peer-reviewed work published abroad. A third tension is that the Humanities and Social sciences are areas which are less visible in the prevailing policy discourse than the Natural and Health Sciences. We know though that access to a Health Science education is restricted through a selection process so the initial interest of students could reflect a different pattern. Different teaching costs may also impact on research funding in different departments.

In these conclusions we focus on two main areas; the achievements of the university researchers and on research policy.

The accomplishments of Icelandic scientists

The evaluations reveal that Icelandic scientists have been making great advances on the international scene for the past years. In 1988, the number of articles published in cited foreign journals was 128. In comparison the number had gone up to 452 in 2001.

Clearly, researchers have been gaining ground internationally. The accomplishments of the Icelandic researchers are greater than those of other countries. The University of Iceland plays a great part in this international success. Accordingly 80% of the articles published in cited foreign journals were written by scholars working at the University or in institutions connected to it. Evidently, there are very efficient researchers working at the University though it should also be noted that 82% of all

funds spent in universities in Iceland on research is spent at the University of Iceland (table 14).

There are some gender differences in research activity. Women are less likely to be inactive researchers at the University but also less likely to be among the most active researchers. The mean research points are similar for men and women and the median is the same.

It is interesting to note that the performance is fairly similar across research fields even though the publishing trends are different. Hence, the Humanities are mostly based on books and chapters, as is known and Science and Engineering and Health Sciences are more likely to publish articles in international journals. A closer look at the research points reveals that publications in ISI journals make up for approximately 20% of the total research points. Books and book chapters make up for approximately 18% of the total research points.

At the same time that the appraisal reveals that there are highly active researchers at the University of Iceland, it also indicates that a sizeable percentage is not active in research. One fifth of the employees received less than 15 points total in 1999 to 2002.

Survey results report strong support among University faculty for increasing the University of Iceland's commitment to research. Those who were interviewed regarding the evaluation all agreed on the positive effect of the productivity assessment scheme on research productivity.

Recommendations

- University of Iceland academics have formally designated research obligations, and individuals are generally expected to devote 40 to 43% of their hours to doing research. For the university to achieve its research objectives, it is essential that faculty honor this commitment. It is also essential that they work within an institutional environment that encourages and supports research. Presently, there are few minimum requirements for accomplishments in research at the University, with the exception of a requirement for a minimum of 15 research points a year for the change of working conditions at the age of 55. The transferal of a work quota at the age of 60 requires a minimum of 25 research points a year. University policy-makers could consider introducing some minimum research activity for a longer or a shorter period of time for all employees who have research obligations.

- As regards the productivity assessment system, it might be useful to introduce a criterion related to the quality of the publication. An evaluation of journals by impact factors could be considered. More points could be awarded for major projects, i.e. publications in science journals with high impact factors as well as important books.

- Further interaction between universities and private industry should be encouraged where possible. Although research in a university should not necessarily be driven by the need to be applied or targeted at commercial applications, it should provide support for those who wish to engage in technology transfer.

- Collaboration among researchers and research groups nationally and internationally ought to be supported and assisted. Ideally such an interest would grow organically out of the research itself and not out of any extrinsic motivation, political or otherwise. The university should seek to provide more opportunities for encouraging international collaboration.

Research policy

The emphasis on research at the University of Iceland has been increasing in the last years and decades. This trend is in line with what has been happening throughout Europe and other industrialized nations, and reflects near universal assessment of the increased importance of universities as generators of the scientific and technological knowledge. Mindful of its historic mission to educate Icelandic citizens and to both preserve and contribute to the nation's cultural heritage, the University of Iceland today has assigned highest priority to enhancing its performance as a research institution. This priority is evident in various policy declarations of the university, as well as rules and goals concerning the development of higher education. Furthermore, there seems to be an almost complete agreement among faculty at the university regarding the increased emphasis on its role as a research university.

This priority is consistent with and accords with Government objectives and policies, both in science and technology and in the expected contribution of the nation's higher education institutions towards these objectives.

To strengthen its research capacity and become internationally regarded as a high performance research university, the University of Iceland must overcome several obstacles, some internal to its operations, some set by external factors.

First, the University of Iceland has set itself the objective of being "a top-quality research university" and at the same time of fulfilling its educational role in the interest of the nation. Strengthened research and educational programs are frequently synergistic undertakings. However, the objectives may indeed compete with one another, especially in austere fiscal environments. To reach the objective of being "a top-quality research university" the institution needs opportunities, financial and otherwise, to strengthen graduate education.

Second, the mathematical model (reiknilíkanið) for allocating funds to the University is based, for the most part, on teaching under current conditions. The funds are allocated according to units completed by the students. This may encourages the proliferation of students up to a certain limit where it becomes a disadvantage as no

further funds are received. It may also encourage a standard study choice. The mathematical model encourages the University to accept large numbers of students, but at present provides little incentive or support for it to encourage research performance. The amount awarded is fixed. Therefore, there is no palpable advantage to the university in being successful in research endeavors.

In general, the way in which the available funds are utilized is of critical importance. The Council for Science and Technology's suggestion that an increased percentage of research funds be channeled through competitive funds is an important step in this direction. A competitive research fund might open opportunities for running high quality facilities for basic research and for hiring top research personnel. In this way, corporations wishing to lend support to research operations could have a competitive opportunity equal to that of universities and government institutions. The central point is that opening up the system to all those who wish to compete and who want success to be the criterion by which funds are allocated would place those funds in the hands of those who do their work best. As a knowledge-based society, Iceland must ensure that those who have the desire and the ability to do so can compete on an equal basis for research funding.

Recommendations

- To be able to reach its objectives as being "a top-quality research university" the University and the Government need to work together in order for the University to reach its objectives in education and research.

- The Government's financing of research in universities has to be reorganized. Less of the research funding should be tied up in direct salary costs, institutions and projects and more should be channeled through competitive funds. This recommendation is in accordance with the government policy.

- It is important that the requirement that the University be a successful research institution be built into its operations although final decisions on allocations within the universities and between departments and individuals should be made at institutional level. Distributing a basic amount of funding according to a research contract plus allocating a certain amount extra to the university based on research performance, is one way to provide incentives for the institution. In addition to the basic sum, the institution could hence receive a "bonus" through success in research work. Other universities would compete also for these merit payments.

Appendix I

AN EVALUATION OF SCHOLARLY WORK AT THE UNIVERSITY OF ICELAND

TERMS OF REFERENCE

The request for the study

The evaluation is carried out at the request of the Ministry of Education, Science and Culture. The Universities Act of 1998 emphasizes increasing autonomy of higher education institutes in managing financial and human resources. At the same time the Act emphasizes the monitoring role of the Ministry. The current evaluation is carried out to meet these requirements. The evaluation is carried out according to regulation on quality control in higher education, issued by the Ministry of Education, Science and Culture in 1999.

A modern call for visibility

One of the main aspects of the discussion on research in the Western world nowadays is the requirement for an evaluation of its success. Science is becoming more important for those who wish to improve national welfare, since factors such as economic growth and improved health increasingly depend on the cultivation of new knowledge, including the renewal of traditional technologies, alongside utilizing natural resources. Thus, the accumulation of new knowledge, its distribution and utilization are now some key issues in political discussions. Furthermore, the scientific community now needs to show the significance and success of its work, to justify funds obtained from government as well as private parties.

The University of Iceland is a publicly funded university and hence the same demands apply to its work, as to other areas funded by public money; the demands for efficiency and success have increased. The current evaluation will make the performance and impact of the University more visible to governmental bodies, university administrators, faculty, students and other stakeholders, including private interests, thus prodding and guiding internally motivated improvements.

The policy basis of the study

The study is conducted out in accordance with the research objectives set forth by the Science and Technology Policy Council and the University of Iceland with regard to research. The main objectives set forth by the Council are twofold:

- to increase appropriations to scientific and technological activities, and
- to raise the standards of quality and results of scientific work.

The main research policy objectives set forth by the University of Iceland are aimed both at strengthening Iceland's position in international science and at further development of Icelandic knowledge.[90]

The objectives of the study

The evaluation of research at the University of Iceland is guided by four objectives and related research questions.

I. The evaluation will provide information on the contribution of scholars at the University of Iceland to local, Icelandic, and international knowledge.

Research questions include:

- What is the international performance of scholars at the University of Iceland using measures of published articles in international journals and lectures given at international conferences? International performance of scholars at the University of Iceland will be compared to comparable institutes abroad.
- What is the international impact of scholars at the University of Iceland in comparison with comparable universities abroad measured in terms of citations?
- What is the performance of scholars at the University of Iceland using measures of published articles in peer reviewed Icelandic journals, books and book chapters in Icelandic?

Part I includes the following research questions:

- Does the research policy of the University encourage research? Is the policy being implemented in the activities of the University at different levels?
- What research infrastructure exists within departments, university research institutes and clusters? What are their strengths and weaknesses?
- Does the quality control system at the University encourage research activity? What are the strengths of the system? What are the weaknesses of the system?
- Does the salary system of the University encourage research activity? How is the reward system organized?
- Does the public funding system (reiknilíkanið/deililíkanið) encourage research activity?

[90] See the University of Iceland Act no. 41, 22 March 1999; Rules for the University of Iceland, no. 458/2000; University of Iceland Aims and Measures 2003-2005.

II. The evaluation will provide information on whether and to what extent academic criteria govern the allocation of research funds within the University.

Research questions include:

- What is the organization of research funds within the University? In what sense do allocations from the funds encourage research activity? Are academic criteria used when allocating grants?

III. The evaluation will consider the links between the University of Iceland and Icelandic society, including discussing the relations between institutions, industry, businesses and the University.

Research questions include:

- What are the main links between the University and Icelandic society and vice versa (including cooperation of individual researchers and research institutes with other universities, organizations and firms)? Are external members on the University council or on the board of in-house funding schemes or the boards of university institutes?

IV. The evaluation will study the links between the University of Iceland with the global scientific community.

Research questions include:

- What are the main links between the University and scholars and universities abroad (including cooperation of individual researchers and research institutes with other researchers and universities)?

Research design

A mixed method approach is used in the study, i.e. interviews, bibliometric analysis and surveys.

I. All the objectives (I-IV) will be assessed using quantitative bibliometric data. The University of Iceland gathers extensive data from faculty. This data will serve as a foundation for a database created by the research team. The use of this data gives an opportunity to apply several different criteria, and hence gives a broad view of the influence exerted by the University on the local as well as the international scientific community. A list of criteria appears in *Appendix II.*

II. Second, an e-mail survey will be carried out among faculty at the University of Iceland, in order to provide quantitative bibliometric information other than that provided by the database listed above.

III. Bibliometric information will be gathered from "benchmark" universities in other countries, in order to provide comparative information on performance of scholars at the University of Iceland versus abroad. Universities will be chosen

from a list of universities listed as "benchmarks" in the views of faculty at different departments at the University of Iceland (information on that issue will be gathered in interviews).

IV. Third, the study will be based on interviews with staff at the Ministry of Education (the division of universities and the budget office, and also the science office and division of assessment and quality control as relevant), with faculty and staff at the University of Iceland, as well as with faculty and staff at universities in Scandinavia and in the US. The main objective of the qualitative part of the study is to provide information, which the quantitative data cannot provide.

- Interviews with staff at the Ministry of Education as well as with faculty and staff at the University will for example provide in-depth information on the implementation of the policy of the University through various activities, on the strengths and weaknesses of the quality control system at the University and on the relations between the University of Iceland with society, as well as its influence in society.

- Interviews with faculty and staff at universities abroad will provide information on the organization, policy and goals of other "benchmarking" universities in relation to scholarly performance.

V. An analysis will be carried out on existing laws and rules of the University, as well as agreement between the University and the Ministry of Education on research funding. This is done in order to provide information on whether they encourage research activities and are being implemented in the activities of the University.

Appendix II

Criteria used in the study (criteria from Kjaranefnd):

Publications[91]:
Thesis
Candidate- or masters thesis (15 points)
Doctoral thesis (30 points)

Books
Books, academic (0-60 points)
Books, republications (0-10 points)

Academic articles
Articles in scientific publications that are documented in the ISI databases, i.e. Science Citation Index, Social Science Citation Index and Arts and Humanities Citation Index (henceforth called ISI-journals) are peer-reviewed.

Article in internationally acknowledged journals (journals which are cited in ISI journals) (15 points)
Article in other refereed journals (10 points)
Other material in a refereed journal (0-5 points)
Article in a non-refereed journal (0-5 points)

Papers in refereed conference proceedings and book chapters.
Paper in a refereed conference proceedings (5-10 points)
Book chapter (5-10 points)

Other academic activity
Scientific report or memorandum (0-5 points)

Reviews (1-2 points)
Reviews in academic publications.

Lectures:
Lecture at science conferences (3 points)
Lecture for the academic community (1 point)
Plenary lecture at an international conference or keynote address at a conference (5 points)

Posters:
Poster in a scientific conference (2 points)
Poster in other meetings (1 point)

Other academic work:

[91] Number of authors. When there is more than one author, the points are calculated as follows:
2 authors 1,5 x points / 2
3 authors 1,8 x points / 3
4 authors or more 2,0 x points / number of authors

Translations (0-10 points)
Other (0-10 points)
For example: software, patents, psychological tests, bills, design projects etc. All published research material that does not fit into other categories.

Impact:
Citations in the ISI databases (Office of Research will supply this information)
First 10 citations: 1 point/citation.
Next 20 citations: 0,5 point/citation.
Citations exceeding 30: 0,1 point/citation.

Editorial work on academic publications:
Editor of an academic journal (2-5 points/year)
Member of editorial board of an academic journal (1-2 points/year)
Editor of an academic book (2-5 points/book)
Member of editorial board of an academic book (1-2 points/book)

Appendix III[92]

Agreement on research between the Ministry of Education and culture and the University of Iceland.
This agreement between the Ministry of Education and Culture (hereafter the ministry) and the University of Iceland (hereafter UI) is based on law 136/1997 on universities.

1st Paragraph
The purpose of the agreement

This agreement provides a framework for priorities in the development of research at UI during the period of agreement. These are primarily that the university will strengthen research and research training and its infrastructure in such a way that it will be in an optimal position to compete for research funds in the next few years in a changing science and research environment. During the period under agreement UI will place increased emphasis on planning (foresight) with regard to research and science within the university, as referred to in the 7th paragraph of this agreement.

The purpose of the agreement is to increase the potential for UI to carry out its function, as laid out in the 2nd paragraph. The agreement is also intended to spell out the reciprocal responsibilities of parties to the agreement, clarify the goal of scientific work at the university and define further the research environment and the means of assessing success in research.

The Minister of Education has identified areas of government priority with regard to the funding of research at university level. These priorities appeared in the policy agreed to by the Science and Technology Council on 18th December 2003. This agreement is intended to reflect the priorities of the ministry and the policy of the Council.

This agreement does not change the legal responsibilities of the minister nor of the university. The financial commitments made by the government are subject to the parliamentary budget.

2nd Paragraph
The role of UI

According to the 1st paragraph of the law on UI the university is a scientific research and educational organization which provides its students with an education such that they can carry out independent scientific projects and take on a range of jobs in society.

UI during the period under agreement will provide the ministry with details of how it will carry out these legal responsibilities, among other things by setting goals within a long-term strategy and by indicating how the achievement of these goals will be evaluated.

3rd Paragraph
The goals of the agreement

During the period of agreement the *University of Iceland* will:

[92] Unofficial translation by Allyson Macdonald, July 2004.

Endeavor to increase its research productivity, ensure the quality of its research and research training and describe how the productivity of its staff is reflected in changes in salary. Emphasize continuous assessment on these issues.

Bring into use a formal quality assurance scheme which among other things will include an assessment of research achievements and how to react to the results of assessing the research of individuals, departments or institutes. With this scheme it should be possible to ensure that the quality of research and graduate education fulfills demands comparable to those made of universities in OECD countries.

Take an active part in international research programs and projects in which the government participates, such the research framework of the EU and other cooperation, including bilateral cooperation which the university and its staff initiate.

Encourage individuals and groups to compete for national and international grants from competitive funds and thus build up diverse university research, and at the same time increase applications made by scientists to the funds to which UI has access.

Prepare proposals on increased flexibility in the teaching and research responsibilities of staff. The proposals should be presented to the ministry within a year of this agreement being signed.

Emphasize cooperation with public research institutes with the aim of combining strengths and coordinating their activities better with those of UI, among other things with regard to the development of research training.

Encourage scientists to protect their rights to their intellectual property with patents and organize the process of using these rights to the advantage of staff and the organization at the same time.

UI will actively encourage cooperation on research and research training with other universities, institutes and businesses. The participation of these parties in masters' and doctoral studies (research facilities and supervision) is ideal for promoting their cooperation and meeting the needs of the employment sector and society.

Will work at increased cooperation between universities and institutes in rural areas and engage in consultation with them on research and educational activities.

During the period of agreement the **ministry** will:

Work at changes in the financing of research in universities in accordance with the priorities put forward in the policy of the Science and Technology Council from 18th December 2003. The changes are directed at an increased emphasis on the financing of university research through competitive funds.

Will encourage changes in the prerequisites for grants from national competitive funds through connections between the employment sector and public institutes, such that funds are better used and there is increased cooperation between these parties.

Provide access for the scientific sector to international science and technology/innovation funds by paying participation fees.

Will work at ensuring the UI a basic contribution to the financing of research and internal development though in other respects the university should compete for research funds. In such a way it is intended that competitive funds create new opportunities at the same time that competition provides needed restraints.

Strengthen the infrastructure of UI with further development of research equipment, housing and facilities for research. In particular there will be a focus on experimental science and practical subjects and a strategy for improvement will be prepared during the period of agreement.

The ministry will during the period of agreement issue regulations on the manner in which UI should fulfill its obligations with regard to the quality of research and the use of funds intended for research, with respect to the 5th paragraph, law 136/1997.

The ministry will carry out external reviews of research activity in cooperation with UI.

4th paragraph
Financing research

It is expected that general funds for research and other activities of the UI will be 1269 m.kr. in 2004. It is assumed that the annual contribution during the period of agreement will be at least that amount and will be subject to changes in value according to general indicators.
The general funds for research are expected among other things to finance: salary contributions because of research, sabbatical leave, contributions to the assessment of productivity and … fund, overall administration of research, facilities used for research, contributions to the supervision of research training, direct costs of research, participation in competitions for research funds and to provide for basic facilities and investments which are not usually provided for by competitive grants.
In 2004 UI will receive 20 m.kr. in addition, intended for the UI Research Fund. The ministry will also take action to provide for earmarked contributions to the Fund in 2005 and 2006.

In making decisions on the distribution of funds to research for the years 2004, 2005 and 2006 UI will take note of the following factors:

6. Research points, according to the assessment of productivity scheme.
7. Number of students graduating with a master's degree.
8. Number of students graduating with a doctoral degree.
9. Amounts received from international research funds
10. Amounts received from national research funds.

Funds permitting, the ministry will take cognizance of the assessment of productivity scheme used by the UI. The ministry will monitor the development and improvement of assessments methods during the period under agreement.

5th paragraph
Reporting

UI will publish, with its annual account, according to the 2nd section on the national budget and the 7th paragraph of the regulations 116/2001 on the implementation of the

budget, an annual report on the main indicators in its activities, including the total number of students in research related graduate studies (for masters' and doctoral degrees) and according to department. Information on the careers of teachers, their publication record (total productivity, annual productivity) and participation in international research projects must also be made available. UI will also provide the ministry with other information on its research activities when requested.

6th paragraph
Policy and planning

UI will prepare a five year plan, and a yearly plan, with regard to its scientific and research activities.

7th paragraph
Validity of agreement and revision

This agreement is valid for a period of three years, from 1st January 2004.
It is expected that a revision of this agreement will begin not less than six months before its validity expires.

Reykjavík, 19th December 2003

Tómas Ingi Olrich	Páll Skúlason
Minister of Education	Rector, UI

Appendix IV

Standards and requirements for quality of doctoral programs at the University of Iceland

Approved by the University General Forum 21 May 2004

1. Introduction

Research-related postgraduate study for master's or doctoral degrees is the major growth sector in the work of the University of Iceland, and one of the most important aspects of its policy. Development in postgraduate studies strengthens the position of the University as an internationally-recognized research university, and enables the university to fulfill its role as Iceland's highest educational institution.[93] An effective research university is an essential prerequisite for promoting Iceland's competitiveness in scholarship, economic development and culture, in the world's information society.

Postgraduate study at the University has been developing fast in recent years. This applies to numbers of both master's and doctoral students, and to the range of study programs available. The University has set the objective that postgraduate students comprise about 20% of the student body.[94]

Doctoral studies usually follow another university degree (MA or MSc), and are completed with a *viva voce* examination, normally after 3-5 years. While most studies at the master's level are based to some degree upon the student's research, or training in research, this is especially true of doctoral programs, where the main emphasis is upon research carried out by the student under the guidance of a supervisor. Doctoral studies are thus also termed research studies.

Doctoral studies normally consist of individual study, for 90 to 150 credits.

2. Organization of doctoral studies

Doctoral studies are organized by the faculties of the University, which are responsible for the content, structure and implementation of the studies. Para. 1 art. 15 of the University of Iceland Act no. 41/1999 provides that the University Council adopt general rules on master's and doctoral studies and on *viva voce* examinations of doctoral theses. These general rules are stated in Section IV of the Rules for the University of Iceland no. 458/2000, which states, *inter alia*, that faculties of the University may organize master's and doctoral programs in accord with the framework stated there. Further provisions on postgraduate study are made in specific articles of the rules for individual faculties. The faculties may also introduce their own further rules on postgraduate study, which must be

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[93] According to the definition of the Carnegie Foundation in the USA, a *university* is an educational institution which graduates at least ten PhDs, in at least three fields of scholarship, every year. At the University of Iceland, 110 doctoral students were registered in academic year 2003-2004, and it is the only Icelandic higher education institution which has graduated PhDs. In 2003, they numbered eight, from four faculties, and hence the University of Iceland is, in accord with the above, the only higher education institution in Iceland which approaches being termed a *university* in international terms.

[94] See further the booklet *Framhaldsnám við Háskóla Íslands. Áætlun til ársins 2005* [Postgraduate Study at the University of Iceland. Plan until 2005] and the plan *Uppbygging Háskóla Íslands – Markmið og aðgerðir 2002-2005* [Development of the University of Iceland – Objectives and Actions 2002-2005].

confirmed by the University Council. Academic titles awarded on completion of studies are listed in art. 54 of the University's rules. Provisions for master's and doctoral studies for each faculty are in the specific sections of the rules for each faculty. Each faculty has also issued its own rules on postgraduate study, which have been confirmed by the University Council.

3. Quality of doctoral studies: basis in law and regulations

The above-mentioned University of Iceland Act and Rules for the University for Iceland make detailed provision for various formal requirements for postgraduate study, such as postgraduate-study committees, handling of applications, admission requirements, number of credits, duration and composition of study, connection between master's and doctoral studies, supervisors and tutors, requirements for those who assess the studies and final project, external examiners and opponents, study assessment, submission and form of final project, links with other universities, and academic titles. While this creates an important *formal* framework for postgraduate study, hitherto there has no been specific definition of standards for the *quality* of the studies the University wishes to maintain, and the requirements which must be fulfilled by supervisors, fields,[95] departments and faculties for this purpose. It is the University's responsibility to introduce such general standards, and to define such special requirements.[96] The distinction between laws and regulations on the University on the one hand, and standards and requirements on the other is, however, not always clear. Thus the legislation, and especially the rules, makes some provision for quality for studies, and the following standards and requirements are a more detailed construction of the rules. The quality standards and requirements also state various conditions for doctoral studies which do not appear in the University of Iceland Act, nor in the Rules.

4. Standards and requirements for quality of doctoral studies

The University of Iceland lays down overall standards and requirements for quality for doctoral studies, which are to provide guidance to tutors, specialists, students, fields, department and faculties. The standards and requirements are part of the University's quality control system, and these provide part of the basis for the university's claim to be recognized as a research university. These are also the prerequisite for quality evaluation, see section 5 below. Emphasis is placed upon the standards and requirements for quality for doctoral studies at the University being consistent with those of the universities abroad with which the university compares itself.

A distinction is made below between general, academic and practical standards and requirements.

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[95] *Field* here refers to a field or branch of scholarship within a department or faculty, i.e. where a smaller unit than the department or faculty offers a study programme.

[96] This is consistent with a contract on tuition concluded between the Ministry of Education and the University of Iceland on 19 December 2003, which states: "During the period of the contract, the University of Iceland will introduce a clear policy on quality of undergraduate programmes on the one hand, and master's and doctoral programmes on the other. The University of Iceland will continue to develop methods on which evaluation of the quality of study programmes and degrees will be based. This shall be based upon internationally-recognised standards."

- *General* standards form a "framework" with reference to internationally-recognized criteria for quality of doctoral studies.[97]
- *Academic* standards entail minimum requirements of education, supervisory experience and research activity of tutors and specialists.
- *Material* standards entail minimum requirements for the conditions provided to doctoral students by supervisors, fields, departments and faculties. These are concerned with working conditions, facilities to participate in research and conferences, and participation in international collaboration.

4.1 General standards for quality of doctoral studies

- The objective of doctoral studies at the University is to provide students with the knowledge and skills necessary for them to carry out independent research acquire new knowledge and carry out practical work in Iceland and abroad where the ability to apply scholarly methods is required.
- Requirements for the quality of doctoral studies at the University of Iceland shall be comparable with those applying at foreign universities with which the University compares itself. Supervisors, departments and faculties shall seek to ensure and maintain the quality of the studies, *inter alia* by monitoring developments internationally.
- Doctoral studies shall take place in an active research environment in a group of recognized scholars, or in close contact with such a group.
- Efforts shall be made to attract to doctoral studies those students who are most likely to show initiative in research. The selection of doctoral students shall be competitive, based upon equity and fairness.
- A plan for the progress of doctoral studies shall invariably exist at the commencement of the studies. Such a plan shall be both realistic and ambitious. It is important to make good use of the study time, and be disciplined, in order to ensure rapid progress of studies.
- Expectations from students who register for doctoral studies at the University shall be generally clear. There shall be a general requirement that they be active participants in the scholarly community they have joined.
- The operation and costs of student projects in a department or faculty shall be clear from the start.
- Doctoral students shall be enabled to monitor development and master innovations in their field of scholarship, and to exchange information and knowledge with other doctoral students and scholars, *inter alia* by facilitating, as far as possible, their spending part of their study time at foreign universities or research institutes, and attending foreign conferences in their field of scholarship.
- Doctoral students shall, as far as possible, be offered the opportunity to assist tutors and carry out projects for a field, department or faculty.
- Doctoral studies shall promote the student's acquisition of, in addition to specialized knowledge in his/her field of scholarship, extensive general

[97]Special account has been taken of standards introduced by NORFA (Nordisk Forskersutdanningsakademi).

knowledge, including knowledge of academic ethics, and social skills required in their future work.
- Doctoral theses shall be subject to a public *viva voce* examination. Theses shall be thoroughly publicized, published and made accessible to the public.

4.2 Academic requirements for doctoral supervisors

A supervisor shall normally:

- have completed a PhD degree in the relevant field of scholarship, or equivalent qualification;
- be a recognized specialist in the relevant field for scholarship;
- have published writings which *inter alia* are relevant to the student's project, in a forum where strict standards for scholarship apply;
- have publications, as measured in "research points" under the research evaluation system of the University of Iceland, amounting to at least 20 points per year on average over the past five years;[98]
- have experience of supervision in doctoral studies, or at least considerable experience of supervision in master's studies;
- have considerable experience of raising special funding from recognized research funds;
- have considerable experience of research collaboration with internationally-recognized specialists in the relevant field of scholarship outside the University.

4.3 Academic requirements for doctoral committees

Those who sit on doctoral committees shall hold a PhD or equivalent. It is desirable that they also meet most of the other requirements for doctoral supervisors.

4.4 Material requirements for the field, department or faculty for doctoral programs

- Doctoral students shall be provided with research and work facilities which are adequate for their projects.
- Doctoral students shall be assured regular access to supervisors.
- Doctoral studies shall be in connection with a foreign university, e.g. in such a way that the student takes part of his/her studies at that university, or that a representative of that university sits on the doctoral committee.
- Doctoral students shall have the opportunity to attend academic conferences and to present their work there.
- Doctoral students shall be offered regular seminars and an organized forum for discussion.
- Doctoral students shall be provided with social facilities.

5. Responsibility for and monitoring of quality of postgraduate study

[98] Departments are encouraged to introduce their own requirements for publications, in accord with differing publishing traditions, e.g. with regard to number of research points, and the nature of the writings on which they are based.

5.1 Objectives

The objective of quality control in doctoral studies at the University of Iceland is to maintain and raise the quality for the studies, improve their organization, promote greater responsibility of supervisors, departments and faculties, and to ensure the recognition and competitiveness of the study programs in the international arena.

5.2 Responsibility

Supervisors, departments and faculties of the University are responsible for meeting the above-mentioned standards and requirements for quality for doctoral studies.

5.3 Assessment, review, certification, adaptation period

Existing doctoral programs

At the implementation of these standards and requirements for quality of doctoral studies at the University of Iceland, it is assumed that existing doctoral programs meet these standards and requirements, and are, in that sense, certified.

Not later than three years from implementation, an external quality review of all doctoral studies at the University shall have been carried out, on the basis of the above-mentioned standards and requirements.

The Rector of the University appoints for a term of three years a three-man evaluation board, and nominates a chair of the committee, who is responsible for the implementation of the review. The evaluation board functions as determined by a letter of appointment issued by the Rector. The evaluation board issues, on the basis of these standards and requirements, guidelines for self-evaluation by supervisors, fields, departments and faculties responsible for the study programs, determines when a review shall take place, makes a time and work schedule for the review, monitors its implementation and makes a ruling on the basis of the review (certification). The evaluation board calls upon the advice of specialists in the relevant field of scholarship as it deems necessary. The board is assisted by a support group in the University's joint administration, whose role is to assist the board, e.g. by gathering necessary information and data.

Assessment of individual supervisors is carried out on the basis of existing information, or information submitted to the evaluation board by supervisors. In the case of a field, department or faculty, the committee informs them of when the review is to take place, and they appoint a self-evaluation group and a chair. The chair organizes and is responsible for the self-evaluation and the preparation for the self-evaluation report, and liaises with the evaluation board. The self-evaluation report (3-5 pages) shall be completed within two months after notification of external review. The evaluation board verifies the content of the self-evaluation report, if necessary by a visit to the site, and makes a reasoned evaluation of it in a written report within two months of receiving the self-evaluation report. Before the evaluation board finalizes its report, it shall offer the self-evaluation group the opportunity to make written comments on its content. The evaluation board shall consider the self-evaluation group's comments, and then complete its final report. The report shall include a reasoned conclusion on

whether the standards and requirements for quality of doctoral study are met, and whether the study program is thus deemed certified.

If the evaluation board believes that the studies are deficient in meeting the standards and requirements for quality, the supervisor, field, department or faculty shall, within two months, explain how he/she/it intends to respond to this. Within two years from that time, the evaluation board shall determine whether and how the findings of the external review have been responded to. If the committee concludes that there are substantial deficiencies in meeting the standards and requirements, it can decide to revoke the certification.

New doctoral programs

Should a field, department or faculty plan to introduce a doctoral program after these standards and requirements have been implemented, it shall submit an application which describes the intended study program, in the same form as a self-evaluation report, together with a time schedule. The application shall be assessed in the same manner, and on the same criteria, as stated above. If the proposed study program is found not to meet the standards and requirements for quality, in the judgment of the external review group, the study program may not commence until the deficiencies have been demonstrably rectified. Doctoral theses may still be submitted for a viva voce examination as provided in art. 69 of the Rules for the University of Iceland no. 458/2000.

Appendix V

- *The University of Iceland Students Fund* supports student's social and cultural affairs.
- *The University of Iceland Instructional Affairs Fund* shall encourage innovation in teaching methods and improvement to instruction at the University.
- *The University of Iceland Union Fund* supports Icelandic scientific activities and connections between Iceland and Denmark.
- *The University of Iceland Assistants Fund* has the purpose of enabling instructors to hire research and/or teaching assistants and, in addition, for those assistants to acquire training and abilities in scholarly working methods.
- The *University of Iceland Research Fund* (see discussion on page x).
- *The University of Iceland Equipment* Purchase Fund shall strengthen research, instruction and administration at the University, by allocating funds for equipment purchasing.
- *The University of Iceland Productivity Evaluation Fund* shall support research and administration at the University. Members of the Union of University Teachers holding at least 50% positions may apply for payment from the Fund for research in excess of their research obligations, as indicated by an evaluation. The evaluation of research is based on a research assessment system, which is part of the formal quality system of the University of Iceland, using the same criteria as are being used in this evaluation.

Appendix VI

University of Iceland
Research and affiliated institution

The University has numerous research institutes and affiliated institutions which function as centres for research, instruction, conferences and many other activities. www.hi.is/inst.

Árni Magnússon Institute in Iceland
Árnagarður, Suðurgata IS 101 Reykjavík, Tel: 525 4010 • Fax: 525 4035 - www.am.is

Centre for Research in the Humanities
Nýi Garður, IS 101 Reykjavík, Tel: 525 4462 • Fax: 525 4410 - www.hugvis.hi.is

Centre for Women's Studies
University of Iceland, Suðurgata IS 101 Reykjavík, Tel: 525 4595 • Fax: 552 1331 - www.hi.is/stofn/fem

Department of Anatomy
Vatnsmýrarvegur 16, IS 101 Reykjavík, Tel: 525 4821 • Fax: 525 4893.

Department of Biochemistry and Molecular Biology
Vatnsmýrarvegur 16, IS 101 Reykjavík, Tel: 525 4271 • Fax: 525 4886.

Department of Bacteriology
National University Hospital, Hringbraut, IS 101 Reykjavík, Tel: 543 1000.

Department of Biochemistry
Vatnsmýrarvegur 16, IS 101 Reykjavík, Tel: 525 4842 • Fax: 525 4884.

Department of Immunology
National University Hospital, Hringbraut IS 101 Reykjavík, Tel: 543 1000 • Fax: 543 8349.

Department of Odontology
Vatnsmýrarvegur 16, IS 101 Reykjavík, Tel: 525 4892 • Fax: 525 4874.

Department of Pharmacology and Toxicology
Neshagi 16, 107 Reykjavík, Tel: 525 5130 • Fax: 568 0872**.**

Department of Pharmacology
Ármúli 30, IS 108 Reykjavík, Tel: 525 5130 • Fax: 568 0872.

Department of Pharmacy
Hagi, Hofsvallagata, IS 107 Reykjavík, Tel: 525 4462 • Fax: 525 4071.

Department of Preventive Medicine and Family Medicine
Neshagi 16, 107 Reykjavík, Tel: 562 9650 • Fax: 562 2013.

Department of Psychiatry
National University Hospital, Hringbraut IS 101 Reykjavík, Tel: 543 1000 • Fax: 543 4815.

Engineering Research Institute
Smyrilsvegur 22, IS 107 Reykjavík, Tel: 525 4917 • Fax: 525 4632.

Environmental Research Institute
Tæknigarður, IS 107 Reykjavík, Tel: 525 5286 • Fax: 552 5829 - www.uhi.hi.is

Ethical Research Institute
Nýji Garður, Sæmundargata, IS 101 Reykjavík, Tel: 525 4195 • Fax: 551 2167.

Fisheries Research Institute
Tæknigarður, Dunhagi 5, IS 107 Reykjavík, Tel: 525 4056 • Fax: 552 5829. - www.sushi.hi.is

Icelandic Language Institute
Neshaga 16, IS 107 Reykjavík, Tel: 525 8530 • Fax: 562 2699 - www.ismal.hi.is

Institute of Anthropology
Oddi, Sturlugata, IS 101 Reykjavík, Tel: 525 4592 .

Institute of Biology
The Natural Science Building, Sturlugata 7, IS 101 Reykjavík, Tel: 525 4618 • Fax: 525 4069.

Institute of Business Administration
Oddi, Sturlugata, IS 101 Reykjavík, Tel: 525 4500 • Fax: 552 6806.

Institute of Economics
Aragata 14, IS 101 Reykjavík, Tel: 525 4535 • Fax: 525 4096 - www.ioes.hi.is

Institute of Experimental Pathology
Keldur, Vesturlandsvegur, IS 110 Reykjavík, Tel: 567 4700 • Fax: 567 3979 - www.keldur.hi.is

Institute of Nursing Research
Eirberg, IS 101 Reykjavík, Tel: 525 4960 • Fax: 525 4963.

Institute of Physiology
Vatnsmýrarvegur 16, IS 101 Reykjavík, Tel: 525 4830 • Fax: 525 4886.

Institute of Lexicography (Orðabók)
Neshagi 16, IS 107 Reykjavík, Tel: 525 4191 • Fax: 562 4410.

The Vigdís Finnbogadóttir Institute of Foreign Languages
Nýja Garði, Sæmundargata IS 101 Reykjavík, Tel: 525 4456 • Fax: 525 4410 -www.vigdis.hi.is

Institute of History
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Appendix VII

Appendix table 1. Science and Engineering articles in international journals, by region and country/economy: 1988-2001.

Region and country/economy	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Worldwide	466,419	497,102	508,795	515,530	547,617	540,491	567,204	580,809	593,568	594,467	617,762	632,059	632,781	649,795
OECD	386,267	411,328	422,129	429,770	456,039	454,461	475,034	487,111	498,275	495,870	514,070	523,075	520,349	532,756
North America	199,937	210,770	215,389	218,000	224,381	222,723	225,997	229,320	228,504	222,878	223,300	224,866	222,044	226,704
Canada	21,391	22,501	22,792	22,903	24,180	23,824	24,565	24,532	24,583	23,077	22,796	23,417	22,873	22,626
Mexico	884	1,046	1,038	1,082	1,336	1,502	1,663	1,901	2,124	2,271	2,615	2,925	2,950	3,209
United States	177,662	187,224	191,559	194,015	198,864	197,397	199,769	202,887	201,798	197,531	197,890	198,524	196,221	200,870
Western Europe	143,882	155,249	159,898	163,709	178,406	178,935	193,033	199,688	207,784	210,538	221,670	226,002	225,696	229,173
Austria	2,241	2,675	2,690	2,756	3,047	3,051	3,177	3,477	3,618	3,880	4,172	4,210	4,259	4,526
Belgium	3,586	3,905	4,103	4,164	4,431	4,512	4,949	5,260	5,583	5,509	5,822	5,924	5,739	5,984
Croatia	Na	Na	Na	Na	17	575	508	563	614	631	589	671	704	710
Cyprus	15	15	17	8	22	24	24	41	54	66	61	58	60	74
Denmark	3,445	3,722	3,716	3,776	4,141	4,068	4,458	4,408	4,477	4,512	4,782	4,909	4,929	4,988
Finland	2,789	2,981	3,071	3,211	3,438	3,603	3,974	4,134	4,354	4,523	4,564	4,872	4,878	5,098
France	21,409	22,686	22,937	23,518	26,172	26,225	28,266	29,309	29,755	30,061	31,809	32,097	30,960	31,317
Germany	29,292	31,821	32,295	32,929	35,120	34,103	36,901	38,100	39,123	40,743	43,953	43,550	43,440	43,623
Greece	1,239	1,518	1,397	1,598	1,736	1,759	1,974	2,068	2,265	2,407	2,666	2,705	2,892	3,329
Iceland	69	68	89	104	105	122	137	158	149	147	177	136	154	174
Ireland	790	826	902	915	946	1,003	1,168	1,210	1,269	1,318	1,526	1,526	1,596	1,665
Italy	11,229	12,509	13,062	13,778	15,462	15,279	17,000	17,904	19,342	19,147	20,321	20,819	21,038	22,313
Macedonia	0	0	0	0	1	27	33	34	37	51	42	45	49	74
Netherlands	8,581	9,736	10,176	10,106	11,060	11,360	11,961	12,330	12,438	12,779	12,756	12,642	12,466	12,602
Norway	2,192	2,247	2,426	2,403	2,655	2,637	2,805	2,953	2,950	3,012	3,100	3,127	3,195	3,252

Portugal	429	510	587	640	712	794	914	989	1,090	1,250	1,404	1,765	1,813	2,142
Slovenia	Na	Na	Na	Na	10	404	459	443	478	595	625	707	901	876
Spain	5,432	6,116	6,837	7,269	9,267	9,759	10,534	11,343	12,234	13,040	13,786	14,860	14,776	15,570
Sweden	7,573	8,126	8,172	8,139	8,273	8,547	8,972	9,284	9,697	9,677	9,967	10,129	9,815	10,314
Switzerland	5,316	5,548	5,901	6,098	6,651	6,871	7,372	7,361	7,489	7,912	8,096	8,297	8,454	8,107
Turkey	507	668	750	846	1,048	1,172	1,397	1,713	2,206	2,440	2,818	3,240	3,482	4,098
United Kingdom	36,509	38,195	39,069	30,950	42,404	42,456	45,436	45,993	47,904	46,183	47,916	48,965	49,485	47,660
Yugoslavia	1,211	1,330	1,641	1,447	1,621	496	514	507	568	555	605	622	513	547
All others	28	48	58	57	71	89	101	104	89	103	112	126	99	129
Asia	51,765	56,331	59,282	61,165	68,489	68,965	74,503	78,055	83,545	86,710	95,623	102,318	104,544	113,575
Bangladesh	95	99	116	104	151	153	136	170	155	146	138	168	160	177
China	4,619	5,411	6,285	6,186	6,956	7,566	7,821	9,261	10,070	12,530	13,807	16,197	18,142	20,978
India	8,882	9,744	9,200	9,517	10,100	9,763	9,928	9,591	9,736	9,419	10,066	10,589	10,047	11,076
Indonesia	59	86	104	89	86	103	120	133	137	146	138	172	165	207
Japan	34,435	36,569	38,570	39,590	44,143	43,339	46,692	47,603	50,392	50,171	54,658	56,134	55,413	57,420
Malaysia	208	241	233	260	247	293	345	373	372	339	402	493	470	494
Pakistan	235	263	257	315	277	349	324	339	274	258	276	300	277	282
Philippines	127	149	157	148	150	148	141	151	153	174	167	187	177	158
Singapore	410	517	572	599	755	854	1,022	1,184	1,181	1,338	1,635	1,984	2,301	2,603
South Korea	771	1,035	1,170	1,361	1,759	2,184	2,931	3,806	4,728	5,636	7,075	8,386	9,386	11,037
Sri Lanka	107	101	106	84	82	83	85	82	78	68	75	94	104	76
Taiwan	1,414	1,724	2,119	2,492	3,337	3,693	4,446	4,846	5,696	5,878	6,463	6,838	7,008	8,082
Thailand	287	272	282	298	300	317	383	338	386	415	530	558	655	727
Vietnam	52	66	60	65	74	67	61	102	113	120	107	112	144	158
All others	64	55	50	58	72	54	71	76	74	74	86	106	96	101
Eastern Europe/Central Asia	41,597	43,697	42,836	41,218	43,214	35,976	38,199	36,390	35,074	34,259	34,680	34,421	35,844	33,686
Armenia	Na	Na	Na	Na	21	165	178	182	179	186	169	156	167	152
Azerbaijan	Na	Na	Na	Na	15	197	189	157	125	87	94	70	89	68

Belarus	Na	Na	Na	Na	30	708	1,021	728	597	276	298	616	576	528
Bulgaria	1,089	1,219	1,216	1,169	1,.218	1,380	1,024	963	968	977	931	900	887	784
Czech Republic	2,746	2,995	3,079	2,881	3,132	3,308	2,179	1,993	2,249	2,231	2,333	2,374	2,458	2,622
Estonia	Na	Na	Na	Na	2	177	202	240	248	255	299	320	344	339
Georgia	Na	Na	Na	Na	12	158	136	148	126	135	131	129	141	110
Hungary	1,714	1,847	1,722	1,806	1,824	1,718	1,774	1,826	1,839	1,939	2,144	2,313	2,292	2,479
Kazakhstan	Na	Na	Na	Na	19	250	191	173	143	125	122	109	113	116
Latvia	Na	Na	Na	Na	37	180	159	154	168	152	164	173	159	157
Lithuania	Na	Na	Na	Na	5	149	189	179	196	209	248	284	262	272
Moldova	Na	Na	Na	Na	15	156	159	140	136	116	98	95	96	77
Poland	4,030	4,245	3,999	3,919	4,113	3,848	4,041	4,535	4,597	4,445	4,819	5,195	5,342	5,686
Romania	393	513	377	395	568	507	675	648	871	835	858	909	956	997
Russia	Na	Na	Na	Na	817	19,659	21,612	19,974	18,464	18,343	17,841	17,149	18,271	15,846
Slovakia	Na	Na	Na	Na	44	0	1,151	1,137	1,175	1,051	1,144	997	1,007	955
Ukraine	Na	Na	Na	Na	162	2,894	2,923	2,856	2,600	2,287	2,362	2,351	2,365	2,256
USSR	31,625	32,879	32,443	31,047	31,127	130	Na	Na	Na	Na	Na	Na	Na	Na
Uzbekistan	Na	Na	Na	Na	50	275	290	295	347	264	213	242	273	204
All others	Na	Na	Na	Na	5	116	105	63	45	46	39	38	45	39
Near East/North Africa	7,893	8,389	8,226	8,143	8,410	8,815	9,124	9,627	9,691	10,041	10,500	10,731	11,092	11,777
Algeria	66	73	98	106	120	123	125	151	156	151	165	179	204	225
Egypt	1,130	1,278	1,254	1,429	1,288	1,279	1,380	1,359	1,359	1,242	1,302	1,362	1,376	1,548
Iran	86	91	94	126	150	175	233	271	312	366	523	699	825	995
Israel	4,916	5,134	4,968	4,873	5,234	5,575	5,559	5,921	5,815	6,203	6,240	6,091	6,314	6,487
Jordan	161	174	176	148	135	130	144	153	167	193	217	245	242	240
Kuwait	304	326	368	209	104	112	186	166	240	210	251	298	243	257
Lebanon	54	61	29	47	52	54	62	56	68	96	111	129	139	202
Morocco	113	108	97	128	170	164	182	237	256	298	370	425	471	469
Oman	13	20	27	32	37	42	46	53	63	63	76	88	99	96

Saudi Arabia	569	577	644	613	653	713	734	781	754	682	700	637	595	580
Tunisia	96	107	104	121	131	91	135	147	159	206	230	269	278	344
United Arab Emirates	23	30	33	57	77	109	98	122	145	154	157	137	144	159
All others	362	411	333	256	257	247	239	210	196	177	159	171	161	174
Pacific	12,054	12,802	12,962	12,915	13,775	14,267	15,223	15,922	16,643	16,761	17,719	18,186	17,791	17,743
Australia	9,896	10,730	10,664	10,742	11,452	11,929	12,695	13,387	13,911	13,955	14,710	15,186	14,700	14,788
New Zealand	2,075	1,993	2,227	2,102	2,253	2,256	2,454	2,466	2,684	2,748	2,953	2,927	3,037	2,903
All others	83	78	70	71	70	81	74	69	49	58	57	75	55	53
Central/South America	4,748	5,359	5,848	5,970	6,586	6,488	6,862	7,646	8,344	9,251	10,285	11,325	11,797	13,147
Argentina	1,423	1,518	1,627	1,499	1,526	1,585	1,747	1,969	2,212	2,430	2,546	2,705	2,792	2,930
Brazil	1,766	2,117	2,374	2,640	3,107	2,885	3,073	3,471	3,830	4,362	5,202	2,950	6,195	7,205
Chile	682	745	830	819	835	877	798	899	928	974	987	1,062	1,100	1,203
Colombia	86	111	122	106	125	122	145	167	196	230	237	254	320	324
Costa Rica	55	55	54	55	62	61	66	70	72	78	73	76	82	92
Cuba	67	90	108	94	131	113	141	166	194	177	234	242	282	299
Peru	68	67	77	70	73	66	64	68	72	71	71	60	77	93
Uruguay	42	50	57	64	81	91	84	98	115	133	136	159	158	155
Venezuela	292	328	314	329	377	395	420	430	432	484	528	523	509	535
All others	268	278	286	294	268	292	324	307	292	313	272	293	281	310
Sub-Saharan Africa	4,544	4,504	4,355	4,409	4,356	4,321	4,263	4.161	3,982	4,028	3,985	4,207	3,973	3,990
Cameron	35	41	46	54	58	75	84	73	60	81	77	71	76	75
Ethiopia	71	58	70	93	88	84	86	99	88	109	80	106	90	93
Ghana	37	36	40	47	72	52	67	65	77	88	67	85	95	90
Kenya	291	300	255	260	295	346	280	310	275	256	270	278	237	230
Nigeria	886	864	815	719	666	604	470	464	433	458	418	451	428	332
Senegal	72	80	83	77	93	100	79	77	64	65	73	71	73	62
South Africa	2,523	2,499	2,406	2,552	2,419	2,377	2,459	2,364	2,282	2,237	2,268	2,366	2,237	2,327
Tanzania	64	71	69	77	93	94	105	92	107	100	91	104	100	87

Uganda	21	17	29	20	29	44	39	49	43	55	59	73	78	91
Zimbabwe	116	123	131	103	119	124	139	109	119	123	122	102	104	113
All others	425	415	412	407	425	422	454	459	436	455	459	501	457	490

Appendix table 2. Regional and country portfolio of Science and Engineering articles, by field 1988.

Region and country/economy	Articles	All fields	Clinical medicine	Biomedical research	Biology	Chemistry	Physics	Earth/ space sciences	Engineering / technology	Mathe-matics	Psycho-logy	Social sciences	Health Sciences	Professional fields
	Number	Percent distribution												
Worldwide	466,419	100.0	29.3	15.2	7.5	12.3	13.3	4.1	6.7	2.1	3.4	2.5	0.9	2.5
OECD	398,238	100.0	31.1	15.2	7.7	10.8	12.0	4.1	6.7	2.1	3.7	2.8	1.0	2.8
North America	199,937	100.0	30.4	15.3	8.1	7.5	9.9	4.7	6.8	2.2	4.9	4.1	1.6	4.5
Canada	21,391	100.0	25.9	14.3	14.6	8.1	8.0	5.8	8.1	2.3	4.6	4.4	1.3	2.6
Mexico	884	100.0	24.5	14.9	15.7	11.1	15.7	6.5	4.0	3.4	2.7	1.2	0.1	0.4
United States	177,662	100.0	31.0	15.5	7.2	7.4	10.1	4.5	6.7	2.2	4.9	4.0	1.6	4.8
Western Europe	143,882	100.0	34.6	15.4	6.6	13.1	13.0	3.8	5.6	2.1	2.6	1.7	0.5	1.1
Austria	2,241	100.0	42.1	10.6	6.3	13.8	12.4	2.5	4.4	2.4	2.8	1.4	0.3	1.0
Belgium	3,586	100.0	38.4	17.1	5.4	10.4	11.9	3.0	5.5	2.3	2.8	1.7	0.4	1.2
Cyprus	15	100.0	16.4	8.2	52.5	0.0	0.0	6.6	3.3	0.0	13.1	0.0	0.0	0.0
Denmark	3,445	100.0	54.6	15.9	6.0	4.8	8.6	2.6	2.3	1.7	1.7	1.1	0.2	0.6
Finland	2,789	100.0	51.1	14.3	7.1	6.1	7.0	3.7	4.3	1.8	1.6	1.4	0.6	1.1
France	21, 409	100.0	29.1	16.6	5.9	15.3	17.2	4.7	4.7	3.0	1.8	1.1	0.1	0.4
Germany (East)	3,626	100.0	23.7	13.4	8.9	25.5	14.9	2.0	6.6	1.4	0.7	1.4	0.1	1.4
Germany (West)	25,666	100.0	29.0	15.4	6.2	15.7	16.5	3.3	6.7	2.2	1.8	2.3	0.3	0.7
Greece	1,239	100.0	20.4	8.1	9.3	14.7	16.3	7.9	14.7	4.3	2.4	0.6	0.2	0.9
Iceland	69	100.0	45.0	12.3	6.2	0.0	3.4	17.6	2.2	2.2	1.5	3.6	1.5	4.6
Ireland	790	100.0	35.8	11.9	11.9	9.2	8.7	4.7	3.9	4.5	5.8	1.5	0.6	1.6
Italy	11,229	100.0	38.0	13.4	3.8	15.4	16.2	3.6	5.2	2.3	1.0	0.8	0.1	0.3
Netherlands	8,581	100.0	36.6	15.5	8.2	10.8	11.9	4.1	4.3	1.5	2.7	2.7	0.6	1.0
Norway	2,192	100.0	40.3	13.8	12.8	8.0	4.9	6.4	4.4	2.1	3.9	2.2	0.4	0.8
Portugal	429	100.0	15.7	11.4	6.4	17.6	20.1	5.0	16.0	2.4	2.2	0.9	0.2	2.2
Spain	5,432	100.0	23.3	18.8	8.9	23.8	12.4	3.3	4.2	3.1	1.1	0.7	0.2	0.2
Sweden	7,573	100.0	48.2	17.2	6.9	7.5	7.5	3.2	3.9	1.2	1.8	1.2	0.8	0.6
Switzerland	5,316	100.0	36.3	18.5	4.1	11.9	16.5	2.7	4.2	1.6	1.7	1.7	0.3	0.6

Turkey	507	100.0	33.1	6.0	5.4	15.8	12.4	6.2	13.4	3.3	2.6	0.9	0.0	1.1
United Kingdom	36,509	100.0	36.6	14.8	7.4	9.9	9.1	4.0	6.3	1.5	4.5	2.4	1.2	2.5
Yugoslavia	1,211	100.0	21.3	15.0	3.3	22.1	20.7	3.4	9.2	3.0	0.9	0.4	0.2	0.5
All others	28	100.0	31.2	2.5	6.0	10.0	31.5	10.9	0.0	3.0	3.6	0.0	0.0	1.2
Asia	51,765	100.0	22.4	13.7	7.5	18.2	19.7	2.7	11.6	1.8	1.3	0.5	0.1	0.4
Bangladesh	95	100.0	26.3	6.5	12.8	11.4	15.1	0.5	4.2	1.4	15.8	3.2	1.6	1.1
China	4,001	100.0	13.8	6.7	2.9	13.0	39.1	5.1	13.0	3.9	0.1	1.7	0.1	0.5
Hong Kong	618	100.0	45.3	9.3	2.4	11.3	7.2	1.7	7.2	3.0	3.5	3.8	1.6	3.7
India	8,882	100.0	12.9	13.6	10.3	24.2	17.4	5.1	11.1	1.8	2.6	0.4	0.1	0.5
Indonesia	59	100.0	21.2	9.6	28.5	4.3	5.9	10.6	6.4	0.8	9.2	1.7	1.7	0.0
Japan	34,435	100.0	25.6	15.2	6.9	17.7	19.1	1.9	11.1	1.4	0.5	0.5	0.0	0.1
Malaysia	208	100.0	31.3	10.3	23.1	12.4	4.1	2.2	3.1	2.6	7.7	0.0	1.0	2.3
Pakistan	235	100.0	8.0	4.6	20.9	34.6	12.6	3.8	11.0	1.3	1.9	0.1	0.6	0.4
Philippines	127	100.0	12.8	3.9	58.0	1.6	0.8	4.7	1.8	2.4	10.2	2.6	0.5	0.8
Singapore	410	100.0	30.4	9.0	7.1	12.1	8.5	2.7	12.7	4.5	7.0	2.4	0.4	3.1
South Korea	771	100.0	10.0	4.6	3.7	30.5	18.2	1.5	24.9	2.7	2.5	0.1	0.0	1.3
Sri Lanka	107	100.0	27.9	15.6	21.2	12.0	3.4	6.2	3.7	0.0	5.4	0.5	2.8	1.4
Taiwan	1,414	100.0	19.7	8.7	9.2	12.8	16.3	0.9	25.4	2.7	3.8	0.2	0.0	0.5
Thailand	287	100.0	42.4	19.4	12.8	3.7	2.6	4.7	4.7	0.9	6.3	0.8	0.5	1.1
Vietnam	52	100.0	1.9	1.6	6.8	9.0	41.3	1.0	2.6	35.8	0.0	0.0	0.0	0.0
All others	64	100.0	41.2	15.2	13.8	3.9	5.3	4.4	6.2	1.6	7.0	1.6	0.0	0.0
Eastern Europe/Central Asia	41,597	100.0	14.4	17.1	3.0	27.2	25.8	3.7	4.8	1.6	1.1	0.7	0.0	0.5
Bulgaria	1,089	100.0	9.0	39.2	2.2	20.6	17.7	2.2	5.4	2.8	0.2	0.3	0.0	0.3
Czechoslovakia	2,746	100.0	16.5	13.9	4.6	29.0	14.5	3.6	5.3	1.5	7.9	2.9	0.1	0.3
Hungary	1,714	100.0	21.2	19.5	3.7	27.3	12.0	1.7	4.3	6.2	2.2	0.7	0.1	1.1
Poland	4,030	100.0	12.4	9.3	5.3	27.1	28.4	1.9	9.1	4.4	1.0	0.6	0.1	0.6
Romania	393	100.0	10.0	3.7	1.3	38.3	18.2	1.5	15.1	9.6	1.3	0.8	0.0	0.3
USSR	31,625	100.0	14.3	17.7	2.6	27.1	27.6	4.1	4.1	0.9	0.6	0.6	0.0	0.4
Near East/North Africa	7,893	100.0	30.1	10.9	9.2	13.0	12.0	4.5	8.9	3.1	3.4	2.1	0.5	2.3
Algeria	66	100.0	17.1	7.5	7.9	17.9	23.9	9.1	2.3	4.6	6.8	2.3	0.0	0.8

Egypt	1,130	100.0	13.5	5.5	11.4	39.7	10.1	4.6	12.8	1.2	0.8	0.3	0.0	0.2
Iran	86	100.0	26.0	7.5	20.5	9.1	6.2	4.8	9.8	8.2	3.9	1.2	0.0	2.9
Israel	4,916	100.0	33.6	13.6	8.8	5.8	13.7	3.4	6.2	3.5	4.7	3.1	0.7	3.0
Jordan	161	100.0	31.6	3.7	6.3	19.4	13.2	2.8	14.0	1.9	3.4	0.6	0.6	2.5
Kuwait	304	100.0	38.4	12.3	4.5	7.6	3.1	9.9	16.8	2.8	1.0	0.7	0.7	2.1
Lebanon	54	100.0	41.8	15.4	9.9	6.2	16.0	1.8	6.5	0.0	1.8	0.0	0.6	0.0
Morocco	113	100.0	12.1	2.3	16.1	24.5	18.2	9.7	9.1	4.9	2.7	0.4	0.0	0.0
Oman	13	100.0	1.9	1.5	18.7	16.8	9.0	41.0	3.7	7.5	0.0	0.0	0.0	0.0
Saudi Arabia	569	100.0	39.2	8.0	6.8	11.4	5.9	4.6	16.2	3.3	1.2	0.4	1.1	1.9
Tunisia	96	100.0	37.5	5.9	5.5	20.7	12.8	4.1	1.0	10.7	1.6	0.0	0.0	0.0
United Arab Emirates	23	100.0	33.0	4.3	0.0	13.0	0.0	2.2	43.2	4.3	0.0	0.0	0.0	0.0
All others	362	100.0	18.4	3.4	14.3	27.3	8.2	11.0	14.7	1.0	0.3	0.0	0.0	1.4
Pacific	12,054	100.0	29.6	13.1	18.3	7.8	6.7	6.3	4.4	2.1	4.9	3.5	0.8	2.4
Australia	9,896	100.0	29.9	13.8	16.1	8.2	7.1	6.3	4.5	2.2	5.2	3.3	0.9	2.5
New Zealand	2,075	100.0	28.4	10.1	28.6	6.1	4.6	6.1	3.8	1.5	3.2	4.6	0.6	2.3
All others	83	100.0	33.8	5.5	25.1	3.8	0.6	12.4	3.6	1.2	8.0	1.2	1.2	3.6
Central/South America	4,748	100.0	24.3	16.6	11.6	11.4	16.2	5.0	5.3	2.2	3.6	1.7	1.3	0.6
Argentina	1,423	100.0	21.9	17.6	11.6	14.9	18.5	4.3	6.2	1.3	2.2	1.3	0.0	0.2
Brazil	1,766	100.0	20.4	15.8	9.1	9.9	22.1	5.3	5.9	3.6	2.2	2.3	3.0	0.4
Chile	682	100.0	38.7	19.1	9.5	11.1	5.8	6.2	3.5	2.4	2.1	1.0	0.0	0.7
Colombia	86	100.0	26.6	11.8	23.6	2.4	2.4	6.0	5.8	0.0	7.3	5.8	4.7	3.5
Costa Rica	55	100.0	19.0	9.1	36.2	4.1	9.1	1.1	2.1	0.0	14.6	2.7	0.0	1.8
Cuba	67	100.0	21.4	15.3	10.8	20.5	21.3	2.5	1.5	0.0	6.0	0.0	0.7	0.0
Peru	68	100.0	24.0	10.3	31.0	3.8	1.6	12.9	2.2	0.0	12.5	1.5	0.2	0.0
Uruguay	42	100.0	39.4	22.3	18.1	7.2	2.4	6.0	2.4	0.0	0.0	0.0	2.4	0.0
Venezuela	292	100.0	21.4	19.9	11.2	13.8	17.0	3.7	6.0	2.2	3.3	0.5	0.0	1.0
All others	268	100.0	27.6	11.0	20.3	5.4	1.6	4.8	2.3	0.7	18.7	3.0	1.9	2.5
Sub-Saharan Africa	4,544	100.0	37.6	12.1	18.7	7.1	3.6	6.0	4.1	1.8	5.0	1.0	1.0	2.1
Cameroon	35	100.0	15.0	18.0	25.6	9.8	0.0	2.7	2.9	14.5	4.3	0.0	7.2	0.0
Ethiopia	71	100.0	39.2	2.1	30.5	8.4	2.8	11.7	0.5	1.4	0.7	0.0	2.8	0.0
Ghana	37	100.0	32.5	9.4	27.6	2.7	0.0	6.9	1.3	0.0	11.6	2.7	0.0	5.3

Kenya	291	100.0	56.4	12.2	19.7	1.2	0.7	1.7	0.7	0.3	4.9	1.4	0.3	0.3
Nigeria	886	100.0	31.6	9.0	24.7	6.7	2.0	2.9	4.2	2.1	7.4	0.6	2.6	6.2
Senegal	72	100.0	35.2	23.7	12.5	6.0	0.5	14.5	0.0	3.5	3.5	0.0	0.7	0.0
South Africa	2,523	100.0	35.0	14.4	15.7	8.8	5.3	7.6	5.3	2.0	3.0	1.1	0.4	1.2
Tanzania	64	100.0	38.7	5.7	28.3	0.0	0.8	4.3	3.1	0.0	12.1	0.8	0.0	6.2
Uganda	21	100.0	53.3	0.0	25.7	2.3	0.0	9.3	0.0	0.0	4.7	4.7	0.0	0.0
Zimbabwe	116	100.0	56.4	2.9	22.2	0.4	0.0	3.4	0.9	0.9	8.2	0.9	1.7	2.2
All others	425	100.0	48.6	8.3	18.6	4.6	1.4	3.8	1.8	0.6	10.0	0.7	0.9	0.7

Appendix table 3. Regional and country portfolio of Science and Engineering articles, by field 2001.

Region and country/economy	Articles	All fields	Clinical medicine	Biomedical research	Biology	Chemistry	Physics	Earth/ space sciences	Engineering/ technology	Mathe matics	Psycho- logy	Social sciences	Health Sciences	Professional fields
	Number	Percent distribution												
Worldwide	649,795	100.0	28.4	14.2	6.8	11.9	13.4	5.4	9.0	2.2	3.1	2.3	1.4	2.0
OECD	551,402	100.0	30.7	15.0	6.8	10.3	11.9	5.4	8.2	2.0	3.3	2.6	1.6	2.2
North America	226,704	100.0	31.3	16.7	6.7	7.2	8.6	5.8	7.0	1.8	4.6	3.9	2.5	3.7
Canada	22,626	100.0	29.3	15.2	10.3	7.8	6.6	7.3	7.9	1.9	4.7	4.4	2.2	2.4
Mexico	3,209	100.0	18.7	12.0	14.8	10.5	21.2	7.6	7.7	2.1	1.7	1.5	1.8	0.5
United States	200,870	100.0	31.7	16.9	6.2	7.1	8.7	5.6	6.9	1.8	4.7	3.9	2.5	3.9
Western Europe	229,173	100.0	32.0	14.0	6.6	11.5	12.7	5.7	8.1	2.4	2.8	1.8	1.2	1.3
Austria	4,526	100.0	42.5	13.0	5.6	10.0	11.3	4.6	6.1	2.7	2.2	1.2	0.3	0.6
Belgium	5,984	100.0	32.9	14.6	8.0	11.0	12.5	4.5	7.8	2.1	2.7	2.0	0.7	1.3
Croatia	710	100.0	23.4	7. 5	6.2	20.5	11.3	4.6	5.0	3.1	16.4	1,3	0.3	0.3
Cyprus	74	100.0	7.7	5.3	4.0	12.2	8.7	2.0	24.0	9.4	13.1	1.9	0.0	11.7
Denmark	4,988	100.0	34.2	17.9	11.7	7.8	9.3	6.2	5.3	1.4	3.3	1.0	0.9	1.0
Finland	5,098	100.0	37.8	14.1	10.1	7.5	8.5	5.5	7.3	1.3	1.8	1.8	2.0	1.9
France	31,317	100.0	27.1	15.2	5.7	12.9	16.1	6.6	9.0	4.4	1.4	0.9	0.2	0.5
Germany	43,623	100.0	30.9	14.1	5.2	12.7	16.3	5.0	8.5	2.2	1.8	2.0	0.6	0.7
Greece	3,329	100.0	31.3	8.1	9.2	12.5	14.1	6.3	11.4	3.0	2.1	0.5	0.4	1.1
Iceland	174	100.0	31.9	10.2	16.2	3.3	4.6	16.2	2.9	2.1	5.8	3.9	2.3	0.7
Ireland	1,665	100.0	30.7	14.6	14.0	8.4	10.3	3.0	6.9	2.4	4.1	1.7	1.6	2.5
Italy	22,313	100.0	35.1	12.0	4.5	11.9	16.2	6.0	8.8	2.9	1.3	0.7	0.2	0.4
Macedonia	74	100.0	11.7	6.8	1.4	51.2	13.4	2.0	12.2	1.4	0.0	0.0	0.0	0.0
Netherlands	12,602	100.0	37.5	14.2	6.0	8.6	8.8	5.5	6.4	1.4	3.9	3.6	1.8	2.2
Norway	3,252	100.0	33.4	12.7	12.9	6.3	5.0	10.1	6.2	2.3	4.4	3.1	2.0	1.7
Portugal	2,142	100.0	14.5	12.5	11.0	20.5	16.8	4.7	13.1	3.5	1.4	0.9	0.1	1.0
Slovenia	876	100.0	19.9	13.7	4.3	16.3	16.7	2.9	17.4	3.1	3.5	0.7	0.3	1.2
Spain	15,570	100.0	24.7	13.9	10.7	18.5	11.7	5.7	7.8	3.3	1.7	0.9	0.4	0.6
Sweden	10,314	100.0	36.7	15.5	7.4	8.3	10.5	4.4	8.1	1.2	1.9	1.7	3.1	1.1

Switzerland	8,107	100.0	32.7	16.1	5.8	12.8	13.4	6.4	6.6	1.4	2.1	1.4	0.6	0.7
Turkey	4,098	100.0	44.3	6.3	5.2	14.2	8.9	4.6	11.2	1.3	1.9	1.1	0.5	0.6
United Kingdom	47,660	100.0	32.8	14.2	6.2	8.5	9.0	5.9	7.4	1.6	5.7	3.0	2.7	3.0
Yugoslavia	547	100.0	19.1	8.8	3.8	17.5	17.2	4.3	23.9	3.9	0.8	0.5	0.0	0.2
All others	129	100.0	34.2	8.9	5.9	12.2	4.6	6.8	11.7	1.5	6.6	0.8	2.5	4.5
Asia	113,575	100.0	22.2	11.9	5.5	18.2	19.8	3.6	14.5	2.0	1.0	0.4	0.2	0.6
Bangladesh	177	100.0	21.5	8.0	12.2	17.4	14.0	4.8	8.7	0.3	6.6	0.0	3.9	2.7
China	20,978	100.0	10.7	8.0	3.8	26.3	23.4	4.4	16.3	3.9	1.1	0.5	0.4	1.3
India	11,076	100.0	14.3	13.4	6.5	25.5	18.6	5.2	13.0	1.2	1.5	0.2	0.2	0.4
Indonesia	207	100.0	22.0	10.3	19.3	8.8	7.7	9.6	10.0	0.2	8.5	0.6	1.0	1.9
Japan	57,420	100.0	28.7	14.0	6.1	14.9	19.1	3.0	11.6	1.4	0.5	0.5	0.1	0.1
Malaysia	494	100.0	20.4	7.6	15.1	28.4	6.4	2.9	12.1	1.0	2.9	0.5	0.8	2.0
Pakistan	282	100.0	19.4	9.3	15.6	16.2	20.6	2.8	8.9	1.7	2.1	0.0	2.4	1.1
Philippines	158	100.0	15.8	10.6	39.5	1.3	12.0	4.0	3.2	1.9	5.3	1.9	1.4	3.3
Singapore	2,603	100.0	14.3	9.1	2.6	11.4	21.0	2.0	27.8	3.4	3.5	0.8	0.3	3.8
South Korea	11,037	100.0	17.9	11.3	3.3	17.7	22.4	3.0	20.7	1.7	1.0	0.3	0.2	0.6
Sri Lanka	76	100.0	27.4	9.1	31.3	11.1	9.2	3.4	2.4	0.0	2.4	0.0	0.7	3.0
Taiwan	8,082	100.0	24.1	8.5	5.1	14.0	16.0	5.0	21.8	2.1	1.2	0.5	0.5	1.2
Thailand	727	100.0	36.6	10.5	16.2	15.2	3.3	4.6	8.4	0.4	1.9	0.5	1.8	0.5
Vietnam	158	100.0	16.2	7.2	13.7	8.6	22.2	3.9	8.8	15.4	0.7	0.0	1.5	1.7
All others	101	100.0	31.0	6.1	18.9	4.5	3.0	15.4	2.0	1.5	10.7	1.3	2.1	3.5
Eastern Europe/Central Asia	33,686	100.0	8.2	8.8	4.4	26.0	30.3	5.9	10.2	3.7	1.4	0.6	0.1	0.3
Armenia	152	100.0	8.2	5.2	1.0	24.0	49.4	4.7	5.7	1.3	0.3	0.0	0.0	0.0
Azerbaijan	68	100.0	2.0	1.6	0.7	39.4	28.1	8.8	11.5	7.8	0.0	0.0	0.0	0.0
Belarus	528	100.0	4.2	8.5	4.1	29.0	40.2	1.2	8.4	3.3	0.3	0.8	0.0	0.2
Bulgaria	784	100.0	12.8	12.3	6.3	24.4	19.5	5.6	13.2	4.3	0.6	0.2	0.4	0.4
Czech Republic	2,622	100.0	14.5	16.0	7.7	22.9	16.2	4.5	8.2	3.9	3.1	1.5	0.0	1.3
Estonia	339	100.0	16.4	15.2	10.5	9.2	19.1	8.2	12.2	2.0	3.1	1.2	2.1	0.6
Georgia	110	100.0	6.8	3.5	4.7	21.1	36.6	7.6	7.8	9.3	2.6	0.0	0.0	0.0
Hungary	2,479	100.0	26.7	13.1	5.2	23.5	15.0	2.8	7.0	3.9	1.6	0.8	0.1	0.3

Kazakhstan	116	100.0	3.5	0.9	2.2	44.7	22.1	9.5	8.5	7.6	0.0	0.0	0.0	0.9
Latvia	157	100.0	10.8	11.5	5.5	27.2	25.1	2.5	14.2	1.6	0.6	0.6	0.3	0.0
Lithuania	272	100.0	7.2	14.3	7.5	19.4	27.7	4.4	12.5	3.3	2.9	0.4	0.4	0.0
Moldova	77	100.0	1.7	2.5	4.5	39.7	40.7	0.4	9.2	1.3	0.0	0.0	0.0	0.0
Poland	5,686	100.0	13.2	8.6	4.8	26.7	26.5	4.1	11.0	3.9	0.5	0.3	0.1	0.4
Romania	997	100.0	3.5	2.5	1.1	34.9	29.0	2.5	18.3	7.4	0.5	0.2	0.1	0.0
Russia	15,846	100.0	3.2	7.5	4.0	27.1	35.6	8.1	8.9	3.4	1.3	0.6	0.1	0.2
Slovakia	955	100.0	12.2	17.5	4.8	22.5	15.9	3.4	8.5	3.4	8.2	3.2	0.1	0.3
Ukraine	2,256	100.0	3.4	2.5	2.1	20.6	44.9	4.2	19.5	2.6	0.1	0.2	0.0	0.0
Uzbekistan	204	100.0	1.4	1.8	1.9	43.5	36.2	4.8	5.7	2.9	2.0	0.0	0.0	0.0
All others	39	100.0	4.7	2.2	8.2	18.3	21.2	19.5	5.1	12.7	3.0	2.5	2.5	0.0
Near East/North Africa	11,777	100.0	29.0	9.6	6.6	14.5	14.2	3.8	11.6	3.8	2.3	2.0	1.0	1.6
Algeria	225	100.0	5.2	2.1	3.1	16.0	34.5	5.9	27.6	5.4	0.0	0.0	0.0	0.2
Egypt	1,548	100.0	20.2	5.1	6.4	29.9	17.7	3.6	15.4	0.5	0.6	0.4	0.1	0.1
Iran	995	100.0	19.5	3.7	3.7	39.6	13.5	2.9	12.3	3.9	0.4	0.3	0.1	0.1
Israel	6,487	100.0	32.9	12.7	6.9	7.6	13.6	3.4	8.3	4.0	3.5	3.3	1.5	2.4
Jordan	240	100.0	18.7	6.6	12.1	9.6	11.6	10.9	25.0	0.4	1.9	1.2	1.5	0.4
Kuwait	257	100.0	35.6	10.4	6.8	10.3	3.8	3.7	21.2	3.0	0.4	0.8	1.0	2.8
Lebanon	202	100.0	48.2	7.5	6.5	4.3	8.5	4.8	6.9	3.0	5.6	1.1	1.5	2.0
Morocco	469	100.0	12.1	5.0	6.7	23.5	21.9	7.6	12.5	10.1	0.5	0.0	0.0	0.2
Oman	96	100.0	41.5	5.3	11.7	4.6	8.9	5.0	17.4	1.6	2.1	1.0	0.0	1.0
Saudi Arabia	580	100.0	40.8	5.9	4.7	12.3	10.1	2.8	17.2	4.0	0.7	0.2	0.2	1.2
Tunisia	344	100.0	22.9	11.3	5.3	15.2	14.1	3.7	14.5	11.9	0.8	0.0	0.0	0.2
United Arab Emirates	159	100.0	45.8	9.1	3.4	6.6	6.8	5.1	14.0	1.6	1.6	2.5	0.8	2.8
All others	174	100.0	25.4	7.3	17.3	13.3	8.9	5.6	17.5	1.1	1.4	1.0	0.2	0.9
Pacific	17,743	100.0	28.2	12.6	16.2	6.6	6.4	8.1	6.4	1.7	4.8	3.8	2.6	2.6
Australia	14,788	100.0	28.7	13.1	14.7	6.8	6.9	7.8	6.6	1.7	4.8	3.7	2.7	2.6
New Zealand	2,903	100.0	25.9	10.5	23.6	5.7	4.2	9.3	5.2	1.8	4.4	4.4	2.5	2.5
All others	53	100.0	30.9	4.6	35.5	1.9	0.0	6.4	1.4	0.0	9.6	0.9	1.5	7.2
Central/South America	13,147	100.0	22.7	14.1	12.7	13.4	17.9	5.4	7.6	2.3	1.8	0.6	1.0	0.5
Argentina	2,930	100.0	23.4	15.0	16.1	12.7	16.0	6.0	6.4	1.8	1.5	0.6	0.2	0.2

Brazil	7,205	100.0	21.4	13.8	10.3	13.5	21.6	4.3	8.8	2.4	1.6	0.5	1.4	0.3
Chile	1,203	100.0	26.8	11.6	12.3	17.3	8.0	11.2	5.9	3.0	2.0	0.3	0.6	1.1
Colombia	324	100.0	24.2	12.4	18.8	8.4	16.6	3.5	4.7	2.4	4.3	2.1	1.4	1.1
Costa Rica	92	100.0	21.1	14.9	37.9	10.9	4.9	4.5	1.8	0.0	2.5	0.3	0.0	1.1
Cuba	299	100.0	25.0	20.1	9.4	15.9	17.0	3.6	6.0	0.3	0.0	2.3	0.4	0.0
Peru	93	100.0	31.4	9.5	24.2	3.1	8.9	9.4	4.0	1.1	6.2	1.1	0.8	0.3
Uruguay	155	100.0	21.3	24.2	13.2	8.9	16.7	4.7	3.1	3.9	0.9	1.8	0.0	1.3
Venezuela	535	100.0	19.3	14.2	12.6	17.4	13.7	4.5	9.3	3.9	2.7	0.2	0.4	1.7
All others	310	100.0	29.4	13.3	26.0	6.8	4.2	6.1	3.6	0.5	5.5	1.3	1.8	1.7
Sub-Saharan Africa	3,990	100.0	29.8	12.0	21.2	6.6	4.4	7.7	5.0	1.5	5.7	1.8	2.3	1.9
Cameroon	75	100.0	34.1	9.2	26.5	4.2	5.3	6.6	2.0	3.1	6.2	0.0	1.3	1.3
Ethiopia	93	100.0	54.2	6.9	21.5	3.8	5.1	3.4	0.3	0.0	2.6	0.4	2.0	0.0
Ghana	90	100.0	40.3	9.6	16.0	5.0	2.3	4.1	2.8	0.0	13.0	1.1	1.2	4.5
Kenya	230	100.0	36.0	13.3	31.3	2.2	0.9	3.4	0.9	0.0	8.1	0.6	2.9	0.2
Nigeria	332	100.0	29.7	11.5	29.9	3.9	2.4	4.0	4.6	2.1	5.4	0.1	2.4	4.1
Senegal	62	100.0	33.8	9.8	30.1	2.7	5.4	4.4	1.9	1.6	6.2	0.0	2.5	1.6
South Africa	2,327	100.0	24.5	12.7	18.0	8.9	5.9	10.3	6.8	1.7	5.2	2.7	1.5	1.8
Tanzania	87	100.0	53.7	6.5	22.0	0.0	0.6	3.5	2.1	0.0	1.0	2.0	5.2	3.5
Uganda	91	100.0	45.6	9.4	21.8	0.0	0.0	2.3	1.1	0.0	4.4	2.1	11.7	1.6
Zimbabwe	113	100.0	29.5	11.4	27.5	2.3	0.0	4.0	5.3	0.4	10.2	2.2	6.3	0.9
All others	490	100.0	37.6	12.6	23.0	4.2	2.7	4.2	2.0	2.2	5.8	0.4	3.4	1.9

Appendix table 4. Citation of Science and Engineering articles, by region and country/economy; 1992, 1996 and 2001.

Region and country/economy	1992		1996		2001	
	Number	Percent worldwide	Number	Percent worldwide	Number	Percent worldwide
Worldwide	2,684,777	100.00	3,325,455	100.00	3,846,519	100.00
North America	1,503,880	56.02	1,770,128	53.23	1,830,781	47.60
Canada	111,661	4.16	141,278	4.25	144,247	3.75
Mexico	2,906	0.11	4,243	0.13	8,241	0.21
United States	1,389,314	51.75	1,624,607	48.85	1,678,293	43.63
Western Europe	812,461	30.26	1,082,741	32.56	1,363,912	35.46
Austria	11,023	0.41	16,437	0.49	23,775	0.62
Belgium	20,776	0.77	28,118	0.85	34,731	0.90
Croatia	0	0.00	871	0.03	1,510	0.04
Cyprus	24	0.00	60	0.00	196	0.01
Denmark	20,271	0.76	26,288	0.79	32,558	0.85
Finland	14,704	0.55	21,493	0.65	30,461	0.79
France	116,453	4.34	153,159	4.61	187,325	4.87
Germany	157,285	5.86	207,673	6.24	274,520	7.14
Greece	3,359	0.13	5,132	0.15	8,971	0.23
Iceland	314	0.01	578	0.02	868	0.02
Ireland	3,440	0.13	4,639	0.14	8,148	0.21
Italy	54,805	2.04	83,353	2.51	115,461	3.00
Macedonia	0	0.00	22	0.00	135	0.00
Netherlands	57,498	2.14	76,260	2.29	91,238	2.37
Norway	10,221	0.38	13,079	0.39	16,212	0.42
Portugal	1,460	0.05	2,793	0.08	5,807	0.15
Slovenia	0	0.00	871	0.03	2,317	0.06
Spain	22,199	0.83	42,731	1.28	68,894	1.79
Sweden	48,980	1.82	57,349	1.72	66,394	1.73
Switzerland	43,605	1.62	58,346	1.75	69,675	1.81
Turkey	1,134	0.04	2,519	0.08	6,565	0.17
United Kingdom	221,955	8.27	278,930	8.39	316,752	8.23
Yugoslavia	2,865	0.11	1,822	0.05	771	0.02

All others	89	0.00	218	0.01	630	0.02
Asia	209,591	7.81	279,456	8.40	392,036	10.19
Bangladesh	208	0.01	331	0.01	317	0.01
China	9,910	0.37	16,539	0.50	33,245	0.86
India	14,421	0.54	19,250	0.58	24,442	0.64
Indonesia	164	0.01	293	0.01	485	0.01
Japan	174,471	6.50	219,688	6.61	280,360	7.29
Malaysia	386	0.01	499	0.02	986	0.03
Pakistan	362	0.01	421	0.01	456	0.01
Philippines	341	0.01	467	0.01	642	0.02
Singapore	1,179	0.04	2,787	0.08	5,650	0.15
South Korea	2,260	0.08	6,563	0.20	23,551	0.61
Sri Lanka	184	0.01	147	0.00	201	0.01
Taiwan	4,763	0.18	11,150	0.34	19,422	0.50
Thailand	787	0.03	1,042	0.03	1,716	0.04
Vietnam	57	0.00	164	0.00	307	0.01
All others	99	0.00	117	0.00	256	0.01
Eastern Europe/Central Asia	52,023	1.94	60,215	1.81	76,898	2.00
Armenia	0	0.00	118	0.00	243	0.01
Azerbaijan	0	0.00	59	0.00	51	0.00
Bulgaria	1,522	0.6	2,110	0.06	2,193	0.06
Belarus	0	0.00	500	0.02	1,060	0.03
Czechoslovakia	5,468	0.20	6,540	0.20	7,591	0.20
Estonia	0	0.00	376	0.01	1,204	0.03
Georgia	0	0.00	88	0.00	264	0.01
Hungary	4,755	0.18	5,988	0.18	8,345	0.22
Kazakhstan	0	0.00	77	0.00	120	0.00
Latvia	0	0.00	224	0.01	443	0.01
Lithuania	0	0.00	270	0.01	710	0.02
Moldova	0	0.00	105	0.00	141	0.00
Poland	8,671	0.32	10,692	0.32	14,909	0.39
Romania	571	0.02	1,109	0.03	1,751	0.05
Russia	0	0.00	19,047	0.57	31,602	0.82
Slovakia	0	0.00	777	0.02	2,411	0.06

USSR	31,036	1.16	9,852	0.30	0	0.00
Ukraine	0	0.00	2,078	0.06	3,606	0.09
Uzbekistan	0	0.00	173	0.01	219	0.01
All others	0	0.00	32	0.00	35	0.00
Near East/North Africa	25,502	0.95	31,975	0.96	43,463	1.13
Algeria	127	0.00	194	0.01	282	0.01
Egypt	1,455	0.05	1,643	0.05	2,391	0.06
Iran	143	0.01	347	0.01	1,756	0.05
Israel	21,192	0.79	27,261	0.82	34,625	0.90
Jordan	218	0.01	165	0.00	382	0.01
Kuwait	460	0.02	154	0.00	571	0.01
Lebanon	62	0.00	79	0.00	273	0.01
Morocco	180	0.01	295	0.01	740	0.02
Oman	48	0.00	52	0.00	121	0.00
Saudi Arabia	1,078	0.04	1,104	0.03	1,291	0.03
Tunisia	170	0.01	199	0.01	438	0.01
United Arab Emirates	33	0.00	141	0.00	461	0.01
All others	336	0.01	341	0.01	332	0.01
Pacific	58,661	2.18	70,735	2.13	92,447	2.40
Australia	49,989	1.86	60,266	1.81	78,789	2.05
New Zealand	8,498	0.32	10,326	0.31	13,507	0.35
All others	174	0.01	143	0.00	151	0.00
Central/South America	12,657	0.47	19,714	0.59	34,879	0.91
Argentina	3,386	0.13	4,856	0.15	8,631	0.22
Brazil	5,132	0.19	8,630	0.26	17,365	0.45
Chile	1,826	0.07	2,560	0.08	3,559	0.09
Colombia	256	0.01	335	0.01	654	0.02
Costa Rica	174	0.01	197	0.01	362	0.01
Cuba	136	0.01	262	0.01	665	0.02
Peru	223	0.01	218	0.01	278	0.01
Uruguay	104	0.00	464	0.01	685	0.02
Venezuela	789	0.03	1,296	0.04	1,491	0.04
All others	630	0.02	896	0.03	1,189	0.03
Sub-Saharan Africa	10,001	0.37	10,491	0.32	12,104	0.31

Cameroon	87	0.00	159	0.00	238	0.01
Ethiopia	117	0.00	173	0.01	226	0.01
Ghana	50	0.00	110	0.00	164	0.00
Kenya	791	0.03	822	0.02	983	0.03
Nigeria	744	0.03	651	0.02	519	0.01
Senegal	358	0.01	372	0.01	279	0.01
South Africa	6,348	0.24	6,397	0.19	7,056	0.18
Tanzania	123	0.00	231	0.01	324	0.01
Uganda	68	0.00	121	0.00	287	0.01
Zimbabwe	274	0.01	239	0.01	301	0.01
All others	1,042	0.04	1,216	0.04	1,727	0.04

Appendix VIII

Appendix table 5. Collaboration of Icelandic scholars with colleagues in other countries

Country	Number	%	Country	Number	%
1. Sweden	213	27,20	26. Czech Republic	6	0,77
2. USA	199	25,42	27. Poland	6	0,77
3. Denmark	135	17,24	28. Brazil	5	0,64
4. England	130	16,6	29. Israel	5	0,64
5. Norway	122	15,58	30. Rumania	5	0,64
6. Finland	77	9,83	31. Colombia	4	0,51
7. Germany	76	9,71	32. Mexico	4	0,51
8. Nederland	52	6,64	33. Slovenia	4	0,51
9. France	51	6,51	34. Argentina	3	0,38
10. Italy	39	4,98	35. Egypt	3	0,38
11. Scotland	38	4,85	36. Estonia, Latvia, Lithuania	3	0,38
12. Japan	25	3,19	37. India	3	0,38
13. Spain	25	3,19	38. South Africa	3	0,38
14. Belgium	22	2,81	39. Chile	2	0,26
15. Canada	22	2,81	40. Taiwan	2	0,26
16. Switzerland	22	2,81	41. Turkey	2	0,26
17. Australia	21	2,68	42. Bermuda	1	0,13
18. Ireland	19	2,43	43. Chorea	1	0,13
19. Portugal	18	2,30	44. Indonesia	1	0,13
20. Greece	11	1,40	45. Iran	1	0,13
21. China	11	1,40	46. Pakistan	1	0,13
22. Austria	10	1,28	47. Philippines	1	0,13
23. Hungary	10	1,28	48. Uruguay	1	0,13
24. Russia	8	1,02	49. Venezuela	1	0,13
25. New Zealand	7	0,89	50. Yugoslavia	1	0,13

Appendix IX

Appendix table 6. Correlation of points for bibliometric contributions for professors, associate professors and assistant professors at the University of Iceland in years 1999-2002

	1	2	3	4	5	6	7	8	9	10	11	12
1. Articles in refereed journals listed in ISI database	1.00											
2. Articles in refereed journals not listed in ISI database	.12	1.00										
3. Books	-.10	.28**	1.00									
4. Book chapters	.06	.29**	.42**	1.00								
5. Papers in conference proceedings	.26**	.08	.02	.13*	1.00							
6. Scientific reports or memoranda	.23**	.54**	.18**	.25**	.24**	1.00						
7. Reviews in academic publications	-.04	..30**	.21**	.26**	.07	.32**	1.00					
8. Plenary lectures at international conferences or keynote addresses at conferences	.29**	.17**	.01	.20**	.20**	.16**	.04	1.00				
9. Lectures at scientific conferences	.32**	.38**	.10	.35**	.30**	.45**	.16**	.47**	1.00			
10. Lectures for the academic community	.15*	.36**	.23**	.23**	.13**	.37**	.03	.18**	.38**	1.00		
11. Editors of academic journals and academic books	.08	.28**	.13*	.25**	.06	.27**	.20**	.20**	.29**	.10	1.00	
12. Members of editorial boards of academic journals and academic books	.20**	.29**	.08	.25**	.08	.40**	.20**	.14*	.25**	.18**	.32**	1.00

* p<.05 **p<.01 (two tailed)

Appendix table 7. Correlation of points for bibliometric contributions for professors, associate professors and assistant professors at the field of Social Science in years 1999-2002.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Articles in refereed journals listed in ISI database	1.00											
2. Articles in refereed journals not listed in ISI database	.53**	1.00										
3. Books	.13	.34**	1.00									
4. Book chapters	.15	.21*	.35**	1.00								
5. Papers in conference proceedings	.44**	.17	-.01	-.06	1.00							
6. Scientific reports or memoranda	.46**	.69**	.16	.04	.30*	1.00						
7. Reviews in academic publications	.17	.35**	.06	.32*	.22	.46**	1.00					
8. Plenary lectures at international conferences or keynote addresses at conferences	.17	.04	.24	.25*	.15	.16	.18	1.00				
9. Lectures at scientific conferences	.52**	.36**	.11	.24	.50**	.54**	.30*	.48**	1.00			
10. Lectures for the academic community	.34**	.18	.23	.19	.22	.30*	-.09	.21	.56**	1.00		
11. Editors of academic journals and academic books	.25*	.31*	.16	.13	-.03	.16	-.06	.04	.23	.24	1.00	
12. Members of editorial boards of academic journals and academic books	.48**	.52**	.16	.31*	.11	.38**	.15	.22	.37**	.24	.34**	1.00

* p<.05 **p<.01 (two tailed)

Appendix table 8. Correlation of points for bibliometric contributions for professors, associate professors and assistant professors at the field of Humanities in years 1999-2002.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Articles in refereed journals listed in ISI database	1.00											
2. Articles in refereed journals not listed in ISI database	.21	1.00										
3. Books	.01	.18	1.00									
4. Book chapters	.18	.37**	.35**	1.00								
5. Papers in conference proceedings	.19	.39**	.21	.15	1.00							
6. Scientific reports or memoranda	.11	.50**	.06	.32**	.38**	1.00						
7. Reviews in academic publications	-.03	.27*	.12	.07	.16	.20	1.00					
8. Plenary lectures at international conferences or keynote addresses at conferences	.33**	.52**	-.05	.33**	.25*	.27*	-.02	1.00				
9. Lectures at scientific conferences	.42**	.63**	.14	.54**	.48**	.40**	.09	.67**	1.00			
10. Lectures for the academic community	.12	.55**	.22	.28*	.35**	.46**	.07	.34**	.46**	1.00		
11. Editors of academic journals and academic books	.06	.41**	-.01	.16	.19	.35**	.40**	.42**	.39**	.10	1.00	
12. Members of editorial boards of academic journals and academic books	-.11	.12	-.14	.15	.14	.47**	.31**	.14**	.09	.08	.38**	1.00

* p<.05 **p<.01 (two tailed)

Appendix table 9. Correlation of points for bibliometric contributions for professors, associate professors and assistant professors at the field of Health Sciences in years 1999-2002.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Articles in refereed journals listed in ISI database	1.00											
2. Articles in refereed journals not listed in ISI database	.22	1.00										
3. Books	-.11	.05	1.00									
4. Book chapters	.80**	.08	.01	1.00								
5. Papers in conference proceedings	.64**	.04	.03	.76**	1.00							
6. Scientific reports or memoranda	.73**	.33**	-.06	.62**	.45**	1.00						
7. Reviews in academic publications	.10	.07	-.04	.10	-.03	.12	1.00					
8. Plenary lectures at international conferences or keynote addresses at conferences	.46**	.44**	.11	.47**	.13	.56**	.25	1.00				
9. Lectures at scientific conferences	.46**	.23	-.04	.44**	.07	.68**	.06	.64**	1.00			
10. Lectures for the academic community	.26*	.44**	.14	.15	.27*	.40**	.13	.15	.23	1.00		
11. Editors of academic journals and academic books	.32*	.20	.15	.26*	.19	.31*	-.06	.21	.14	.03	1.00	
12. Members of editorial boards of academic journals and academic books	.35**	.35**	-.12	.25	.09	.50**	-.06	.34**	.33*	.21	.28*	1.00

* p<.05 **p<.01 (two tailed)

Appendix table 10. Correlation of points for bibliometric contributions for professors, associate professors and assistant professors at the fields of Engineering and Natural Sciences in years 1999-2002.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Articles in refereed journals listed in ISI database	1.00											
2. Articles in refereed journals not listed in ISI database	.05	1.00										
3. Books	.02	-.04	1.00									
4. Book chapters	.10	.03	.11	1.00								
5. Papers in conference proceedings	.15	.03	.08	.36**	1.00							
6. Scientific reports or memoranda	.24*	.38**	.29**	.10	24*	1.00						
7. Reviews in academic publications	-.02	-.08	.07	.02	.20	-.02	1.00					
8. Plenary lectures at international conferences or keynote addresses at conferences	.30**	.04	-.03	.17	.19	.02	.13	1.00				
9. Lectures at scientific conferences	.26*	.38**	-.04	.34**	.50**	.43**	.20	.40**	1.00			
10. Lectures for the academic community	.14	.27*	.25*	.10	.09	.32**	.15	.15	.34**	1.00		
11. Editors of academic journals and academic books	.17	-.13	-.03	.35**	.13	.17	-.03	.17	.20	-.02	1.00	
12. Members of editorial boards of academic journals and academic books	.16	-.10	.43**	.20*	.20*	.28**	.12	.05	.13	.11	.28**	1.00

* p<.05 **p<.01 (two taile