EVALUATION OF THE DANISH NATIONAL RESEARCH FOUNDATION CENTRES OF EXCELLENCE

REPORT OF AN INTERNATIONAL PANEL

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PREFACE (1)

The Danish National Research Foundation has, with the mission to promote science at the highest international level, established 44 centres of excellence and commissioned a number of other initiatives within the Danish research system. Over a period of 10 years approximately 2 billion DKK has been spent on these research initiatives, all of which are results of international assessment of scientific quality.

When the European Commission published its KEY FIGURES 2001 on indicators for benchmarking of national research policies, Commissioner Phillip Busquin stressed the importance of setting up analytical work concerning the context and content of national policies on research in an attempt to identify best practices. Together with Sweden and Finland, Denmark was amongst the best-rated nations in the report. The Danish centres of excellence program in a 10-year perspective might yield important information in respect of best practices. Hence in 2002, as 16 centres of excellence established in 1993/94 were evaluated by independent panels of 3-4 international experts within each their field of research, the Board of the Foundation found it pertinent to commission an overall analysis aimed at identifying best practices in a small country. A panel of 9 international scholars from Europe and North America were asked to "take a 'bird's eye view'" on how the 16 centres had performed and critically analyse the strategies adopted by the Foundation in its attempts to improve the quality of Danish research.

The panel has carried out its analyses during the first half of 2003 visiting Denmark twice and listening to views expressed by several actors within the Danish research system including scientists, politicians and industrialists. In this report the panel presents its analysis and the main conclusions and recommendations as to how the Foundation should proceed in the future. The report has been written independently of the Foundation, and an academic secretary outside the Foundation has assisted the panel. (Part of the background material provided to the main panel, including information about the Danish research system and the DNRF strategy for centres of excellence is available on *www.dg.dk*).

On behalf of the Board I am happy to present an analysis, which, elegantly and in a balanced way, identify strengths as well as weaknesses and future challenges. The centres of excellence strategy seem to have proven its excellence, so to say. But more effort needs to be made regarding issues of internationalisation, research training, documentation of social value of the research etc. A new legal act passed through Parliament has strengthened the activities of the Foundation, and with a current discussion by the Board on which strategies to take and initiatives to embark on in the future, such considerations and recommendations are very important input.

It is my hope, moreover, that the material, including this report, will be useful for other European countries as well as in the ongoing attempts to create a European Research Area with intensified collaboration across countries.

Henrik Tvarnø
Chairman of the Board

PREFACE (2)

The members of the International Panel asked to review the Danish National Research Foundation 'Centres of Excellence' initiative were faced with challenging terms of reference, which demanded a rigorous approach to this task. The Panel was particularly concerned that its assessment should make a constructive contribution to the development of the Foundation's policies. Throughout our discussions, right up to finalising our report, I sensed this constructive spirit. The enthusiasm of the Panel was complemented by the cooperation and support we received from the Foundation's Board and staff. That made our work easier.

The Panel's main task was to assess the 'Centres of Excellence' initiative as a novel research funding mechanism. We were guided by the reports of international peer reviewers on the individual Centres. The Panel was impressed, indeed pleasantly surprised, by the scientific quality, in world terms, of some of the Centres. Nevertheless, despite the widespread achievement of high scientific quality by the Centres, we found some scope for improving the extent of internationalisation of Danish research and for increasing research training.

It was clear to the Panel that the Danish research community has strengths and qualities that should make it more attractive to foreign students and researchers and more engaged at both European and international levels, than it is at present. We recommend the introduction of dynamic and imaginative schemes to seize these opportunities.

We have expressed our opinions and conclusions on these, and other matters, clearly in the report that follows.

Overall, the panel found the 'Centres of Excellence' to be a first-class initiative that has had a significant positive impact on Danish research. It now needs political support to make it sustainable and to avoid the gains being dissipated, or even lost.

Enric Banda
Chair, International Review Panel

EXECUTIVE SUMMARY

The outcomes and impacts of 16 Centres of excellence established by the DNRF in 1993/94 lie at the heart of this International Panel evaluation. The DNRF is a major source of funding for basic research in Denmark, despite its modest share (2%) of total public spending on R&D. A key question for the evaluation was whether the Centres are producing an impact at least commensurate with the scale of investment.

Overall, we conclude that the Centres of excellence initiative has been successful in bringing about genuine improvements to the Danish research system. This conclusion is based on our perception of the extent to which the Centres have achieved the Foundation's primary objectives of raising scientific quality, improving research training and enhancing the internationalisation of Danish science.

On the basis of our critical reading of peer reviewers' reports and supplementary information, we conclude that 12 of the Centres have been wholly successful in terms of the DNRF's aims. We consider that about a quarter of the 16 Centres have achieved genuine distinction as world leaders in their scientific fields.

Several of the Centres have an impressive record in research training. Overall, however, more effort is needed to fulfil the Foundation's research training objective across the board.

Similarly, the objective of internationalising Danish science has been achieved unevenly in the Centres we reviewed. The Danish research system needs to develop imaginative ways of attracting more foreign researchers and research students, and encouraging more Danish scientists to gain experience abroad.

Not all the original Centres have demonstrated successful engagement with users or the public generally. In contemporary society it is no longer acceptable to justify public funding of basic research purely by considerations of scientific excellence. A social dividend is expected, even from the most academic aspects of research and scholarship. This can take several forms, including the application of knowledge and technology and public engagement. We believe that the Board should do more to encourage outreach activities generally at Centres and to maintain an open attitude to proposals for new Centres with potential for application.

We noted that the Foundation has adjusted its initial policies and procedures for the Centres in the light of early experience. In general, we were in sympathy with present arrangements for selection, funding, management, monitoring and evaluation, which should be operated with maximum flexibility. In particular, we support the Foundation's policy of not normally funding a Centre for more than two periods of five years. Indefinite support for existing Centres would seriously restrict the Foundation's ability to fund new Centres. It seems to us that a funding period in the range of ten years strikes the right balance between short and indefinite term support. Consequently, transfer strategies need to be addressed at the outset.

We understand that in the depressed state of investments generally, the DNRF currently has to eat into its capital base to continue its operations. This is clearly not sustainable and conflicts with the intention that the Foundation should be a major long-term player in research funding arrangements under new legislation. We recommend that the appropriate authorities take steps to give the Foundation longer-term financial stability.

There are opportunities for embedding Centres in a Nordic and wider European science framework and we recommend these should be explored. In its selection procedures, the Foundation should consider giving greater emphasis to international networking and collaboration. It is likely that successful engagement with FP6, the ERA and Europe at large will require larger Danish research groups. In these ways, Denmark can make a valuable contribution to the integration of European science.

For future challenges facing the Foundation, especially in view of its role in the new legislation, the demands of outreach and the internationalisation of research, the Board is likely to need wider expertise and experience, including users of research outputs.

Finally, the high potential of the Danish science and technology system means that investment in the DNRF Centres of excellence is low risk – high return in the medium and long term. This calls for positive political decisions.

1. INTRODUCTION

Background

1. The Danish National Research Foundation (DNRF) was set up as an independent body by Act of Parliament in 1991 with responsibility for funding basic research of the highest quality. This followed national debate about the importance of basic research in Denmark and the need to nurture the best Danish scientists and to train a new generation of researchers.

Supporting Centres of research excellence

2. The Foundation's chosen funding instrument – awarding large, concentrated grants for several years to research proposals of the highest quality, constitutes the basis of its Centres of excellence strategy. The underlying expectation was that well-funded Centres of research excellence would create the right environment to promote scientific development and encourage research leadership, the training of young researchers and the internationalisation of Danish science.

3. International peer review is an essential element of the Foundation's strategy for Centres of excellence, both at the stage of appraising proposals and in evaluating outcomes and impact. The Centres created at the first funding round in 1993/94 were evaluated as they approached the end of their first five-year period. As a result, seven were discontinued. The 16 Centres that were continued for a second five-year period, and are now approaching the end of that period, have been selected for further international evaluation.

Current review

4. The DNRF decided to adopt a two-stage approach to this second evaluation. The first stage involved between three and five international peers reviewing each of the 16 Centres separately. The second stage, this current review, is to carry out a high level review of the Foundation's Centres of excellence initiative as a whole. The Foundation has appointed an international Main Panel of experts to undertake this latter task. The membership is set out in Appendix 1.

Terms of reference

5. Broadly speaking, the Panel was invited to review the success of the DNRF Centres of excellence initiative as reflected in the development and impact of the first tranche of Centres created in 1993/94. In addition, it was asked by the Chairman of the Foundation to consider whether this type of initiative for supporting research excellence might have relevance and applicability in other European countries. The full remit of the Main Panel is set out in Appendix 2.

Method of working

6. The Panel met in plenary session in Copenhagen on two occasions, on 14-16 April 2003 and on 23-24 June 2003. On the first occasion, we had extensive discussions with Mr Henrik Tvarnø, Chairman of the Board of the DNRF, and with Dr Ole Fejerskov, Director of the DNRF.

7. In April, we also met informally several members of the DNRF Board, Mrs Hanne Severinsen, Chair of the Parliamentary Science Committee, and leading people from the Danish research system, including two university vice-chancellors, the Chair of the Danish Natural Science Research Council, senior members of the Ministry for Science, Technology and Innovation and senior administrators at the DNRF.

8. The reports of international peer reviews of each Centre were the principal evidence base for our task. In addition, the Foundation prepared a thoughtful Working Paper that set the scene, analysed the policies and funding patterns of the first ten years, and posed some important questions[1]. Overall, we were assisted by the substantial documentation provided by the Foundation, all of which is listed in Appendix 3.

9. In accordance with our remit, we looked only at the 16 original Centres, set up in 1993/4 and subject to international peer review in 2002, not at the seven that were terminated after the first review, nor at those selected more recently.

10. To canvass wider views about the Centres and their impacts, we wrote seeking views from representative Danish universities and from selected Danish industrialists and private Foundations.

11. During May we prepared our Report in correspondence and in June reconvened in plenary session in Copenhagen to approve the final draft of the Report and to present it to the DNRF Board.

1 *The Danish Research System and the DNRF strategy for centres of excellence. Experiences after 10 years*. DNRF 2003.

2. CHALLENGES FACING RESEARCH AND HIGHER EDUCATION

The research and higher education base

12. All advanced knowledge-based economies recognise the importance of investing in research and of renewing intellectual capital. The EU has set an ambitious target of spending 3% of GDP on research by 2010. The importance of an intimate linkage between research and higher education, though challenged by some policies for concentrating research funding, is still a widely accepted and desirable paradigm, supported by good empirical evidence.

Funding research elites

13. Across the developed world, expanding higher education sectors are competing for public research budgets that are often static and sometimes diminishing. In this situation, the need to concentrate research funds in order to fund elite research groups adequately has become a central challenge for national research policies. Individual countries have adopted different approaches to targeting funds on internationally competitive researchers who operate at the cutting edge of science. Generically, the main mechanisms are:

    - Generous funding of groups, or centres, selected by peer review within universities and research institutions, usually for medium term periods and sometimes in prescribed high priority areas, such as ICT, biotechnology, nanotechnology, as well as interdisciplinary research.
    - Linking funding to periodic assessment of the entire research community; for example, the UK Research Assessment Exercises (RAEs), which have led to a marked concentration of research funding in the hands of a few, research-intensive universities.
    - Creating of a separate stream of well-resourced research institutions, such as those of the German Max Planck Society, separate from but closely linked with universities, especially in graduate and postgraduate research training.

14. The Academy of Finland has published an overview of selective funding policies in 17 countries around the world[2]. The survey shows that, although there are many different approaches to supporting excellence in research, in reality many countries have adopted a variant of the centres of excellence approach that suits their particular circumstances.

15. Whatever policy instrument for selectivity and concentration is chosen, there will be some inevitable tension between elite groups and the remaining broad base of researchers, especially when funds are tight. A funding policy that is transparent and broadly accepted by the research community at large is more likely to succeed.

European dimension

16. The increasing integration of European research, evidenced by the European Research Area concept, discussions about a European Research Council, as well as the funding incentives for research and training collaboration and networking in Framework Programme 6, is an important influence on national strategies for R&D. An important goal of several national research policies is to make their national research centres better able to compete for EU R&D funds and to provide leadership in EU-wide collaborations.

Interaction with society

17. There is a global trend to link research and the users of research outputs earlier in the process than hitherto. Researchers no longer work in isolation, but interact with users, whether in industry, commerce, the public sector, or, indeed, the public at large, in a wide variety of outreach activities.

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2 *Centre of Excellence Policies in Research: Aims and Practices in 17 Countries and Regions*. Publications of the Academy of Finland 2/01.

3. THE DANISH NATIONAL RESEARCH FOUNDATION

Philosophy

18. In the debate in Denmark about nurturing research elites, several cultural and socio-economic arguments were advanced for supporting basic research:

    - Research is part of Danish, European and global culture. Denmark must contribute to the common effort to continue research-based cultural development.
    - National research capacity is a prerequisite for drawing on global research.
    - Well-conducted research, analysed and interpreted with an open mind can lead to unexpected results that change our perception of the world, sometimes with major practical implications and economic benefits.
    - Research and education go hand in hand. Research is a major driver for updating educational curricula. And modern society needs people whose education has taught them the value of research and who can interpret and mediate the findings of scientific research to the broader public.
    - Research trains a new generation of scientists. There is a demand in both public and private sectors for new researchers who have done basic research at international level as part of their training.
    - Research is needed to provide options for addressing current and future problems in Danish society as part of European and global communities.

Creating the DNRF

19. It was against the background of these intellectual arguments that the DNRF was founded in 1991 as a new player in the Danish research system. The Act setting it up gave the Foundation the main responsibility for basic research within the total Danish research system. In pursuit of these responsibilities, the Foundation was expected to focus its funding on research of the highest quality to enable the best Danish research teams to achieve international recognition. Improving the quality of training of young researchers and increased internationalisation of Danish science were also important aims.

20. The new Foundation was intended to complement existing research funding mechanisms, not replace them. It was to become an important, additional part of the second tier for resource allocation to research, alongside the national research councils and strategic R&D funding from Government ministries.

The DNRF strategy for Centres of excellence

21. The Foundation was given discretion on means, but was encouraged to emphasise research quality and to inform its funding decisions by international peer review. Early in 1992, the Board of the Foundation determined that the best means to meet its primary aim of supporting high quality basic research was to fund Centres of excellence. The Centres were to be funded for periods of five years in order to make the best of them fully competitive on a world scale and to enable them to win further funding from other national or international sources.

22. Through its Centres of excellence initiative, the DNRF sought to tackle the fragmentation that was a consequence of spreading resources thinly across institutions and disciplines. By bringing all the natural sciences, social sciences and humanities under one roof, it was able to emphasise scientific excellence as the key criterion, without regard for disciplinary or institutional balance. International peer review was designed to buttress the primacy of excellence.

23. The concept of well-funded Centres of research excellence broke new ground in the contemporary Danish research landscape. Novel features of the scheme were:

    - Supporting outstanding individuals, not institutions or departments.
    - Providing generous and flexible financial support over five years, with the prospect of extension for a second five-year period.
    - Giving a Centre head or director a considerable degree of autonomy on issues of scientific leadership and resource management.

24. These principles and values are reflected in the selection criteria for proposals. The main requirements are for a coherent and convincing research plan, for research of international quality, and for a scientist with the research experience as well as the leadership and managerial qualities to realise the research plan. The full selection criteria are listed in Appendix 4.

25. Perhaps inevitably, the initiative created tensions within the existing research system, notably between funded Centres and their host institutions, but also with traditional research funding procedures. For instance, a major current issue is the future of those successful centres that are nearing the end of their second five-year period of DNRF funding, following the Foundation's decision in 1999 normally to limit its funding to two periods of five years. Not all host institutions are willing, or indeed able, to takeover the funding responsibility necessary to ensure continuity even in those cases where it would be fully warranted by the excellent quality of a Centre.

26. The initiative, nevertheless, fell on fertile ground and researchers responded with a large numbers of proposals. The first round saw 350 applications, of which only 23 were eventually successful. Seven were terminated after the first five years and new Centres have been added to in subsequent funding rounds. Consequently, there is currently a total of 34 Centres from three rounds of competition. A full list of these 34 Centres is provided in Appendix 5.

27. In summary, the Foundation was created to cut across the existing systems of allocating research funds and of conducting research. Its Centres of excellence initiative has been designed to enable Danish research groups to be full players in the international arena in selected fields and crafted to match the profile and scale of the Danish research system. Selectivity and concentration are its hallmarks. It should be seen, and judged, as a distinctive Danish solution to funding elite research groups adequately.

Types of centre

28. Diversity is a notable feature of the 16 Centres that were the subject of individual evaluation by peer review in 2002. Many are true centres, meeting the template of coherent research groups within a single location, or distributed across two or more locations, pursuing an agreed research plan. Two Centres have emphasised training and have developed strong graduate school programmes. A few are essentially a combination of related research programmes. And a small number are built round an outstanding individual scientist. Some are multi-site; many are single site.

29. An important issue for the evaluation of the initiative was the extent to which each of the Centres has fully exploited the potential of the scheme, for example in terms of training, developing young scientists, creating European and wider international collaboration and partnership.

Scale of operation

30. Finally, it is important not to lose sight of the scale of the Centres of excellence initiative in the wider scheme of the Danish research system. In 2000 DNRF expenditure amounted to 250 million DKK. By comparison, the six national research councils had combined expenditure of 572 million DKK in the same year, though an additional 325 million DKK was attached for joint strategic programmes. Thus, DNRF funding is a major source of funding for basic research, despite its modest contribution (2%) to total public spending on R&D.

31. A key question for the evaluation is whether the Centres are producing an impact at least commensurate with the scale of this considerable national investment in basic research.

4. EVALUATION OF THE CENTRES OF EXCELLENCE INITIATIVE

Introduction

32. The outcomes and impacts of the 16 Centres established in 1993/4 and still functioning lie at the heart of our evaluation. The evidence-based evaluation of these Centres individually was the task of the international peer reviewers, all experts in the appropriate fields, who looked in considerable detail at the self-evaluation reports from each Centre. We sought to take a broader perspective, viewing the Centres collectively and seeking to identify outcomes and impacts beyond contributions to the general fund of knowledge. We addressed separately the three main aims of the initiative – research of the highest international quality, research training and the internationalisation of Danish science.

Research of the highest international quality

33. To gauge scientific productivity and quality, we studied the detailed self-evaluation reports. On scientific judgments, however, we were largely guided by the peer reviewers' assessments, which we found to be thorough and balanced. We concluded that the important objective of research of the highest quality has been successfully achieved. Although we recognise the dangers of making such judgements, we consider that about a quarter of the 16 first round Centres not only achieved the objectives of the scheme, but genuine distinction as world leaders in their scientific fields.

34. We noted that only a few of the Centres had attempted bibliometric analysis in their self-evaluation report. Such studies could inform future evaluations. For example, careful bibliometric analysis could quantify the contribution the Centres are making to Denmark's leading position in measures of international scientific competitiveness in EU member states, the USA and Japan, recently published by the EU[3]. Denmark performed strongly in the indicators of scientific output and impact, notably:

- Number of highly cited papers as a proportion of total scientific publications, (1997-99): Denmark ranked 1st.
- Number of highly cited papers per 1 million population, (1999): Denmark ranked 2nd.

It would be very interesting to know what proportion of these highly cited publications came from DNRF Centres.

Research training

35. Training young researchers in a well-resourced, outward-looking research environment is a main objective of the initiative. So, as well as it being in their selfinterest to attract research students, Centres have a responsibility to create a vibrant research-training environment. We were provided with data on PhD student numbers within the 16 Centres, reproduced in Appendix 6.

36. These data show an uneven picture. Several Centres have pursued research training vigorously as a core activity, prioritising research training in their budgets. Two (SMI and BRICS) have established graduate school programmes with the Foundation's encouragement and have been very successful in attracting students. Others have positively sought to attract foreign students and have participated in schemes such as the EU's Marie Curie Fellowships. But six of the Centres have each had less than 20 PhD students over the decade. And the modest overall number of foreign PhD students rather confirms our general feeling that the Danish system is not sufficiently engaged in attracting non-Danish research students.

3 *Key Figures 2001. Indicators for benchmarking of national research policies*. EC 2001

37. However, it should be recognised that several of the Centres have played a significant role in offering research training and career enhancement opportunities to those employed in the public sector by way of facilitating masters and doctoral theses in their areas of specialisation.

38. Cross-fertilisation of ideas with young people is vital for the future of the Centres and of Danish science as a whole. And the Centres are well placed to contribute to the emergence of a Europe-wide post-doctoral training programme. We applaud imaginative schemes like the summer research school organised by one of the Centres, which attracts top international scientists and outstanding PhD students. Schemes of this sort raise the profile of Danish science and flag PhD and post-doctoral opportunities. But, overall, more effort is needed to fulfil the Foundation's research training objective in several of the Centres, which should be aiming to achieve the levels of the best.

Internationalisation of Danish science

39. Internationalisation of Danish research is the third main objective of the Centres of excellence initiative. There are several inter-connected strands to this, including improved international visibility, greater movement of researchers to and from Denmark and increased European and international collaboration.

40. The Foundation's insistence on international peer review for selecting and evaluating Centres alone has improved the international visibility of Danish science. In their self-evaluations, Centres were asked to benchmark themselves against some of the most successful foreign research groups in their field. Unfortunately, not all the Centres did this systematically, but those who did often demonstrated parity with the other groups in scientific productivity and international standing.

41. International collaboration and networking are essential to the intellectual health of the Centres. Yet the record of the 16 Centres in attracting foreign scientists has been mixed. A common experience has been for foreign scientists to spend only one or two months as visitors. Only a few of the Centres have a significant number of foreigners in senior positions. It appears that young, qualified foreign researchers, who are essential to the intellectual health of the Centres, like research students, do not seem to find the Danish system sufficiently attractive to come in numbers. Their energies and experience in other countries should be driving the Centres of excellence scheme now and in future.

Overall conclusion

42. On the basis of our critical reading of peer reviewers' reports and the supplementary information, we conclude that 12 of the original first round Centres have been wholly successful in terms of the DNRF's aims of cientific development, training young researchers and enhancing the international position of Danish science.

Wider impacts

43. There is clearly a time delay in measuring the full impact of individual Centres and of the initiative as a whole and it may take some years for some Centres to have a measurable effect. As far as impact on the economy is concerned, we were surprised that there was little evidence in the documentation we received concerning the impact the Centres were having on industry and commerce, other than a few scattered remarks in self-evaluation reports. In an attempt to remedy the situation, we interacted with a small, but representative, sample of senior people in Danish knowledge based industry. It is clear from this that industry regards the Centres of excellence initiative very positively.

44. On societal impact, the DNRF has recognised the need for a systematic study, to attempt to measure wider cultural and educational benefits from the Centres, as well the more practical socio-economic and technological benefits. We agree this should be carried out.

45. We were, however, able to identify some of wider impacts in our discussions with leading people in the political, higher education and research communities. These are:

- Widespread acceptance in political and in scientific circles that selectivity and concentration have a role to play in the Danish research funding system.
- The importance of basic science and the DNRF's role in promoting it are also widely accepted and, indeed, form one of three pillars of research support in a new Law before the Danish Parliament.
- Improved national and international visibility of Danish science and higher education.

5. EVALUATION OF DNRF POLICIES AND PRACTICES

46. Since the establishment of 23 Centres in 1993/4, the DNRF's policies and procedures have been adapted, some quite significantly, to changing circumstances and in the light of experience. So it is of greater value for us to comment on the latest procedures, rather than those adopted initially. In doing this we have taken account of the Foundation's present reflections on policies and means of operation, described in the Working Paper the Foundation provided us.

Selection and funding

47. Researchers are the driving force behind imaginative ideas in basic research, though institutions also have an important role at the proposal stage. As the body responsible for promoting basic research, the DNRF should maintain its open invitation, or responsive, approach as an essential feature of its funding policy, resisting any pressures to pre-select particular fields of research and scholarship.

48. As the Centres of excellence initiative targets the highest quality research, it is entirely correct that a key selection criterion should be the potential of a proposal to make a measurable increase in research quality and quantity in the Danish system that could not have been achieved otherwise. We agree strongly with the Board's continuing adherence to this *'make a difference'* principle.

49. The international evaluation of proposals has been a cardinal principle of the scheme since the outset. We agree with the Foundation that it should continue. It is the only way to benchmark against world standing. Indeed, international peer reviewers could be used more extensively in informing the first stage of selection, not just the final selection. This would also ease the heavy burden that this stage of selection imposes on the Board.

50. The Board expressed concerns that the Foundation's initial selection of Centres in 1993/94 may have been too conservative, influenced by a subconscious desire for the initiative to show early success. We believe that a pragmatic approach was prudent initially, striking the right balance between scientific risk and the prospects of successful outcomes. Now the Foundation is established, we believe it could afford to take a few more risks by supporting the unorthodox.

51. The Foundation's has a policy of making grants that are sufficiently large to resource a research group properly and to encourage international networking. We strongly support this distinctive feature of Centre support. Spreading funds too thinly would weaken the chances of a Centre's success and undermine the Foundation's main purpose. We noted that there were few, if any, complaints about the scale of resource in the papers that Centres submitted to this evaluation.

52. With 16 of the original Centres nearing the end of their second five-year periods, duration of funding is a highly topical, and somewhat contentious, issue. The more so since the Foundation decided in 1999 that, for it to retain flexibility and dynamism, it could not normally fund a Centre for more than two periods of five years.

53. We support the Foundation on this issue. The attractions of the initiative lie in its ability to fund new ideas, researchers and groups. On present financial projections, indefinite support for existing Centres would seriously restrict the Foundation's ability to fund new Centres, effectively emasculating it. In these circumstances, a funding period in the range of ten years strikes the right balance between short and indefinite term support.

54. However, for the Foundation's policy of finite funding to work efficiently, the agreement of host institutions to possible transfer strategies must be secured and agreed at the start of funding, and preferably incorporated in a contract. The transfer route could include a measure of natural phasing out. A five-year review, using international peers, should continue to be an important procedure. The results of such a review should feed into, and help crystallise, transfer strategies. The length of second five-year periods could be more flexible, geared to the continuing programme and the agreed transfer strategy. We were pleased to learn that the Foundation is now adopting procedures along these lines.

Centre identity

55. Uneven internal integration has been a feature of the 16 Centres that were evaluated. Many of these Centres grew out of existing groups, often on a single location, with core staff who were already tenured. Such Centres soon inherited the identities and values of their parent research groups, but at a price of not exploring alternative management and organisational structures.

56. On the other hand, those few Centres where sub-groups were located separately have had a problem of coherence and achieving the full potential expected of them. In some cases Foundation initiated meetings have been the only occasions for staff from separate locations to meet.

57. It is important for Centres develop their own identities and cultures and to do this in harmony with their host institutions. The more formal procedures now in place for setting up Centres and embedding them in host institutions should help this process. But we agree with the Foundation that the natural diversity of Centres should always be recognised. A *'one size fits all'* approach to Centre organisation, management, identity and culture is as undesirable as it is unattainable.

Institutional embedding

58. The Foundation's vision was that the Centres of excellence initiative would have long lasting benefits in terms of both direct scientific output and general strengthening of institutional research environments. Reaping the wider, institutional benefits would depend to a large extent on the interactions and collaboration between a Centre and its host institution's teaching and other research activities. However, the tensions inherent in any scheme for supporting research elites were somewhat exacerbated by the DNRF's original, well-intentioned, procedure of inviting grant applications direct from individual scientists, sometimes with little involvement of their institutions. In some cases, proposals for Centres may not even have been consistent with institutional academic, research and resource strategies. This meant that the host institutions of some of the original Centres were inadequately bound into, and committed to, the Centres. Such lack of institutional commitment has made planning more difficult for one or two Centres as they approach the end of their second and last five-year funding period.

59. It was reassuring to learn that the Foundation has now addressed this weakness. Much stronger arrangements are now in place to secure host institution commitment at the outset, notably early informal discussions reinforced by a legal contract between the DNRF, Centre Director and host institution. These agreements normally include possible transfer strategies for Centres when the

DNRF funding ends, whether after five or ten years. This should avoid some of the uncertainty that still surrounds the future of a few of the original Centres, though we were pleased to learn that in most cases transitional arrangements have now been agreed.

Outreach

60. Not all the original Centres have demonstrated successful engagement with users or the public generally. In contemporary society it is no longer acceptable to justify public funding of basic research purely by considerations of scientific excellence. A social dividend is expected, even from the most academic aspects of research and scholarship. This can take several forms.

Application of knowledge and technology

61. We were surprised that so few Centres in the evaluation were on topics with potential for application, whether in industry, commerce or national policy making, and that only two were located at a technical university. We also noted that two of the seven that did not survive the first five-year evaluation were of a technological nature. Application stimulates research and there are many instances of the constructive interaction between technology and scientific discovery. We believe that the Board could adopt a more sympathetic approach to proposals with potential for application, which should of course be subjected to the full rigour of peer review based on scientific criteria.

Public engagement

62. Globally, there is strong social imperative for science to do more in this area. The Foundation should attach greater priority to Centres' outreach plans and performance irrespective of research area. This may require some widening of the skills and experience currently present on the Board.

Advisory groups

63. As a general principle, advisory groups to Centres should have some members from outside academia. This should help promote outreach.

6. RECOMMENDATIONS FOR THE FUTURE

64. Overall, we conclude that the Centres of excellence initiative has been successful in bringing about genuine improvements to the Danish research system. This conclusion is based on our perception of the extent to which the original Centres have achieved the Foundation's primary objectives of raising scientific quality, improving research training and enhancing the internationalisation of Danish science.

65. Our main reservations concern research training and human capital aspects of the internationalisation of Danish science, where progress has been made under the initiative, but where there is still some way to go.

66. Nevertheless, we believe that Foundation has had a positive influence considerably beyond its 2% share of total public R&D funding, not least in influencing attitudes in Denmark towards concentration and selectivity in allocating research funds and helping raise the international visibility of Danish science. The Danish research community has responded well to the opportunity. The role planned for the Foundation in the new Law is testimony to the impact the initiative has had on the Danish Government.

67. Looking ahead, we have a number of recommendations that should help the evolution of the Centres of excellence initiative. Several of these, we know, coincide with the instincts and intentions of the DNRF Board.

Future strategy

Flexibility

68. It is important to have confidence in the original strategy, concept and principles, which remain sound and relevant to the first decade of the 21st century. The original Centres illustrate a diversity that is likely to continue. This should be reflected in arrangements for their nurture and management.

RECOMMENDATION 1.
We recommend strongly that the Foundation should always aim for maximum flexibility in its selection, funding, management, monitoring and evaluation procedures, without compromising scientific quality.

Selection criteria

69. Knowledge-based industry values basic research and looks to the higher education system to provide it with knowledge and a supply of high quality, young researchers with enquiring minds. Application stimulates research.

RECOMMENDATION 2.
While maintaining its primary focus on basic research, the Foundation should sustain an open attitude towards proposals with potential for application.

Transfer strategy

70. We support the Foundation's policy of not normally funding a Centre for more than two periods of five years. A funding period in the range of ten years strikes the right balance between short and indefinite term support.

71. At all stages in the funding process – at the time of new calls, the negotiation of selected proposals and the subsequent drawing up of contracts, the DNRF should insist on a transfer strategy. We were pleased to learn that, following difficulties experienced with the original Centres, this now seems to be standard practice.

RECOMMENDATION 3.
The Foundation should continue its current practice of negotiating practical transfer strategies for new Centres as they reach the end of their DNRF funding. These should always be built into legal contracts between the DNRF, host institutions and Centre directors.

Partnership

72. Now that it is a mature research funder with a track record of success, the Foundation is well placed to benefit from partnerships. Its funds are finite and there may be opportunities for gearing by working with other Danish research funders and industry and commerce, as well as with foreign and international bodies. Partnership funding would be one way of increasing the size of selected Centres. It could also help break down the relative academic isolation we have noted at some of the Centres and promote social context and outreach.

RECOMMENDATION 4.
We recommend that the Foundation explore opportunities for partnership funding of some of its future Centres.

European and wider integration

73. There are opportunities for embedding Centres in a Nordic and wider European science framework and we recommend this should be explored. It is likely that successful engagement with FP6, the ERA and Europe at large will require larger Danish research groups. In these ways, Denmark can make a valuable contribution to the integration of European science.

74. In its selection procedures, the Foundation should consider giving greater emphasis to international networking and collaboration. These could achieve both gearing of scale and a stronger international dimension. The Foundation is proposing more flexible funding arrangements, using Danish funds abroad if necessary, to promote internationalisation of Danish research. We endorse this approach.

RECOMMENDATION 5.
The Foundation should be alert for opportunities for Nordic, European and international integration and be prepared to fund on an appropriate scale to make them effective.

Internationalisation

75. International collaboration and networking are essential to the intellectual health of the Centres. Yet, research students and young, qualified foreign researchers do not seem to find the Danish system sufficiently attractive to come in numbers. Their energies and experience in other countries should be driving the Centres of excellence scheme now and in future. Equally, Danish scientists should benefit from experience in other countries, especially in the early stages of their careers.

RECOMMENDATION 6.
Despite obstacles and rigidities in the system, the Foundation, working with others as necessary, should seek to increase the attractiveness of the Danish system to foreign scientists and to encourage Danish scientists to gain foreign experience.

Management issues

Monitoring

76. While the Panel endorses the more formal monitoring procedures that have been introduced in recent years, a reasonable balance has to be struck between control and delegation. The Foundation should continue to monitor Centres with a light touch and take care not to undermine the autonomy given to a Centre director – a feature of the Centres of excellence initiative that is worth cherishing.

RECOMMENDATION 7.
The Foundation should continue to monitor Centres with a light touch and take care not to infringe the leadership responsibilities of Centre directors.

Gender

77. The gender issue is, rightly, important in contemporary society. We have no reason to believe there are any particular problems in the operation of Centres, other than imbalances currently endemic in scientific professions generally. But we were given no data on gender balance in Centres.

RECOMMENDATION 8.
We recommend that the Foundation adopts the necessary policy and procedures to monitor the development of gender participation continuously and make the results transparent for both the Centres and the wider public.

Evaluation

78. Despite the logistic challenges it would create, we believe that future evaluations of Centres should involve some site visits by peer reviewers.

79. Experience with the current evaluation leads us to the view that the Foundation should develop policies for the systematic measurement of impacts of its strategy – on science, industry, and society generally.

RECOMMENDATION 9.
The DNRF should commission scientometric analysis, including bibliometrics, and other studies of impact for, at least, a selection of the Centres.

The DNRF Board

80. At present the Board consists of nine members, appointed on account of their outstanding research credentials. For the future challenges facing the Foundation, especially in view of its role in the new legislation, the demands of outreach and the internationalisation of research, the Board is likely to need wider expertise and experience, including users of research outputs.

RECOMMENDATION 10.
The Board should review its composition against current and future challenges facing the Foundation.

A sustainable future

81. The Foundation has made a significant impact by changing the perception of research funding and organisation in Denmark. It has already evolved considerably and must continue to evolve to stay ahead of the crest of the wave of changing circumstances, expectations and horizons. Its independence has helped it operate in a flexible and efficient manner.

82. We understand that in the depressed state of investments generally, the DNRF currently has to eat into its capital base to continue its operations, including a planned new funding round. This is clearly not sustainable and conflicts with the intention that the Foundation should be major long-term player in research funding arrangements under new Law.

RECOMMENDATION 11.
To sustain the impact of the Centres initiative on the Danish research system and to maximise the original investment, we recommend that the appropriate Danish authorities take steps to give the Foundation longer-term financial stability.

83. The high potential of the Danish science and technology system means that investment in the DNRF Centres of excellence is low risk – high return in the medium and long term. This calls for positive political decisions.

7. ACKNOWLEDGMENTS

84. We must express our thanks to Mr Henrik Tvarnø, Chairman of the DNRF, Dr Ole Fejerskov, Director, DNRF, Trine Danø and other staff for the excellent arrangements before and during our work in Copenhagen, for the documentation that they provided and, above all, for the friendly and hospitable way in which we were received.

June 2003

APPENDIX 1

MEMBERSHIP OF MAIN PANEL

Professor Enric Banda (Chairman)	*Secretary General*, European Science Foundation
Professor Sir Richard Brook	*Director*, The Leverhulme Trust, United Kingdom
Professor Jens-Erik Fenstad	University of Oslo, Norway
Mr Jean-Claude Gavrel	*Director*, Networks of Centres of Excellence, Canada
Professor Dr Hubert Markl	University of Konstanz, Germany
Professor Cora B Marrett	*Senior Vice-President*, *Academic Affairs*, University of Wisconsin, USA
Professor Gunnar Öquist	University of Umeå, Sweden
Professor Eda Sagarra	*Chairman*, Irish Research Council for the Humanities and Social Sciences, Ireland
Dr Brian Jamieson	*Rapporteur*, United Kingdom

APPENDIX 2

TERMS OF REFERENCE

Terms of Reference of Main Panel

- Assess the role and influence of the Danish National Research Foundation centres of excellence initiative in Denmark as reflected in the development of the centres created 10 years ago.
- Consider if the centres have had a broader impact on the Danish Research Community at large.
- Is it likely that the same amount of money distributed unspecified to the Universities would have resulted in research output of similar standard?
- Assess if the centres rank amongst the best in the world in their respective fields.
- Are the centres likely to be able to contribute to a Danish impact on the European Research Area, and to take initiatives in global research collaboration?
- Consider the Danish initiative in an international perspective by comparing with the research political development and institutional innovation in other countries.
- Assess if the full potential of the centres has been utilised in encouraging and developing new generations of young scientists.
- Consider improvements to the centres of excellence initiative or suggest other strategies to be taken by the Foundation, which may enhance the quality as well as dynamics of Danish research whereby the competitiveness of Danish research can be strengthened.

Finally, the panel is asked to report to the Board of the Danish National Research Foundation, through its Executive Director, in summer 2003.

APPENDIX 3

DOCUMENTATION AVAILABLE TO THE MAIN PANEL

The Foundation provided the Panel with a comprehensive set of documentation, as follows:

- A working paper 'The Danish Research System and the DNRF strategy for centres of excellence', produced by the Foundation for the Main Panel.
- For each of the 16 Centres:
  - A Self-evaluation Report [1994-2002]
  - Between three and five individual international peer review reports based on the Self-evaluation Report.
  - A summary of the individual peer review Reports prepared by the lead reviewer.
- The Foundation's current guidelines, or protocol, for monitoring Centres, introduced in 2002.
- An example of the contract between the Foundation, a host institution and a Centre Director.
- A summary of improvements to the Foundation's procedures in recent years.
- The composition of the Foundation's Board.

APPENDIX 4

SELECTON CRITERIA (ROUND 1)

Absolute criteria

- That a coherent **research plan** exists, and that the research is of top quality at international level.
- That a **head of research** can be appointed who has research experience as well as the capacity to manage a major research enterprise.

The following additional criteria were emphasised

- That there is a group of **highly qualified scientists** from Denmark and other countries who can make up the core of then research activity.
- That it is possible to include qualified **young scientists** and that these can complete a PhD training in the relevant research environment.
- That the activity can attract **foreign scientists** of high standing.
- That the relevant research is likely to achieve **international impact**.
- That the research activity in question is **relevant to Denmark** – e.g. from a cultural point of view or based on the needs on the public or private sector.
- That it is possible to create **something new** which would not otherwise have been carried out within the framework of the existing system.
- That there are proposals of **co-operation** with universities and other institutes of advanced education, and other research institutes as well as industry where relevant.
- That the research group can co-operate with leading groups of scientists in other countries and enter into major **international research programmes** such as the research programmes of the EU.

APPENDIX 5

DNRF RESEARCH CENTRES

A. The 16 original Centres that were the subject of the current international evaluation

SØREN KIERKEGAARD RESEARCH CENTRE (SKC)

Head of centre: Dr. Niels Jørgen Cappelørn

Facts: established 1994, average annual grant: 11 mill. DKK, present granting period: 01.01.1999-30.06.2006.

Scientific profile: The main purpose of the centre is to establish a new complete critical edition of all of Kierkegaard's writings: Søren Kierkegaards Skrifter and to carry out and promote Kierkegaard research from literary, theological and philosophical perspectives at both national and international level.

Location: University of Copenhagen, but independent foundation, St. Kannikestræde 15, Copenhagen K.

THE DANISH EPIDEMIOLOGY SCIENCE CENTRE (DESC)

Head of centre: Professor Jørn Olsen

Facts: established 1994, average annual grant: 10 mill. DKK, present granting period: 01.02.1999-31.12.2005.

Scientific profile: Epidemiological research, including studies of the connection between cancer and virus; diet, alcohol and mortality; heredity and environment studies among twins, fertility studies, studies on measles and the national birth cohort study.

Location: Statens Serum Institut in cooperation with the University of Aarhus and the Copenhagen Hospital Corporation.

THEORETICAL ASTROPHYSICS CENTER (TAC)

Head of centre: Professor Igor Novikov

Facts: established 1994, average annual grant: 8 mill. DKK, present granting period: 01.02.1999-31.07.2005.

Scientific profile: The origin of the Universe's large-scale structures, the formation and development of Galaxies, the structure of the Sun and other stars.

Location: University of Copenhagen and University of Aarhus.

CENTER FOR ATOMIC PHYSICS (ACAP)

Head of centre: Professor Jens Ulrik Andersen

Facts: established 1994, average annual grant: 9 mill. DKK, present granting period: 01.01.1999-31.07.2005.

Scientific profile: Of central importance for ACAP's experimental research is the storage ring for ions and electrons, ASTRID. The purpose is to achieve new knowledge on fundamental structures and processes in nuclear physics. The research is centred on atomic, molecular and optic physics.

Location: University of Aarhus.

CENTER FOR ATOMIC-SCALE MATERIALS PHYSICS (CAMP)

Head of centre: Professor Jens Kehlet Nørskov

Facts: established 1993, average annual grant: 9,6 mill. DKK, present granting period: 01.09.1999-31.12.2003.

*Scientific profi*le: The general theme for the research at CAMP is the study of metallic nanostructures and their properties by a closely coupled experimental and theoretical approach.

Location: The Technical University of Denmark and University of Aarhus.

CENTRE FOR BASIC RESEARCH IN COMPUTER SCIENCE (BRICS)

Head of centre: Docent Mogens Nielsen

Facts: established 1994, average annual grant: 8 mill. DKK, present granting period: 01.01 1999-30.06.2006.

Scientific profile: The aim of the centre is to establish important areas of basic research in Denmark in Mathematical Foundations of Computer Science, notably Algorithmics and Mathematical Logic, alongside existing activities in Semantics of Computation – see also International PhD School in Computer Science.

Location: University of Aarhus and University of Aalborg.

DANISH LITHOSPHERE CENTRE (DLC)

Head of centre: Senior researcher Hans Christian Larsen

Facts: established 1994, average annual grant: 17 mill. DKK, present granting period: 01.02.1999-31.12.2005.

Scientific profile: DLC is studying the fundamental processes underlying the formation and development of the lithosphere. The work has been focused on Greenland and the North Atlantic. The main topics are the geologically recent continental break-up about 60 million years ago of the North American-European continent and the formation of larger continents about two billion years ago.

Location: The Geological Survey of Denmark and Greenland (GEUS) and University of Copenhagen.

DANISH CENTRE FOR EXPERIMENTAL PARASITOLOGY (CEP)

Head of centre: Professor K. Darwin Murrell

Facts: established 1993, average annual grant: 10,6 mill. DKK, present granting period: 01.10.1998-30.09.2003.

*Scientific pro*file: Research is conducted on basic aspects of parasitism, including host-regulation of parasite populations, environmental factors influencing transmission, and on risk factors in parasitic zoonoses. The research encompasses investigations on nutrition and intestinal microflora interactions with helminths, parasite sensory biology, parasite genetics, immunology and development of Integrated Parasite Management approaches appropriate to sustainable and ecological livestock production.

Location: The Royal Veterinary and Agricultural University.

CENTER FOR BIOLOGICAL SEQUENCE ANALYSIS (CBS)

Head of centre: Professor Søren Brunak

Facts: established 1993, average annual grant: 7 mill. DKK, present granting period: 1.9 1998-31.8 2003.

Scientific profile: Bioinformatics and theoretical sequence studies, including predictions on biological sequences by use of neural networks and mathematical/datalogical methods.

Location: The Technical University of Denmark.

THE COPENHAGEN MUSCLE RESEARCH CENTRE (CMRC)

Head of centre: Professor Bengt Saltin

Facts: established 1994, average annual grant: 17 mill. DKK, present granting period: 01.01.1999-31.12.2005.

Scientific profile: The main objective of CMRC is to unravel the signal interaction that secures a proper match of oxygen and substrate supply to the demands of skeletal muscle at rest and when used.

Location: Rigshospitalet (and the Copenhagen Hospital Corporation).

CENTER FOR SENSORY-MOTOR INTERACTION (SMI)

Head of centre: Professor Thomas Sinkjær

Facts: established 1994, average annual grant: 6 mill. DKK, present granting period: 01.10.1998-30.06.2006.

Scientific profile: The purpose of SMI is to study basic and clinical aspects of human sensory-motor interaction and to develop methods to restore impaired sensory-motor functions. The research encompasses three main areas: Motor control research, neural prostheses research and pain research – see also The International School for Biomedical Sciences and Engineering.

Location: Aalborg University.

CENTRE FOR SOUND COMMUNICATION (CSC)

Head of centre: Professor Axel Michelsen

Facts: established 1994, average annual grant: 6 mill. DKK, present granting period: 1.1 1999-31.12 2005.

Scientific profile: The Centre works on problems in sound communication and hearing in animals and the research builds on experiments on a large range of animals (insects to whales).

Location: University of Southern Denmark, Odense.

CENTRE FOR CRYSTALLOGRAPHIC STUDIES (CSS)

Head of centre: Professor Sine Larsen

Facts: established 1994, average annual grant: 6 mill. DKK, present granting period: 1.1 1999-31.12 2003.

Scientific profile: The researchers at CSS are engaged in answering fundamental problems in the field of structural chemistry that focus on the link between the three dimensional structure of molecules and crystals and their properties and function.

Location: University of Copenhagen.

COPENHAGEN POLIS CENTRE (CPC)

Head of centre: Docent Mogens Herman Hansen

Facts: established 1993, average annual grant: 2 mill. DKK, present granting period: 01.09.1998-31.12.2004.

Scientific profile: The aim of the centre is to produce an inventory of all known Greek city-states (polis) in the period from 600 to 300 BC. The work is primarily based on written sources and archaeological evidence.

Location: University of Copenhagen.

CENTRE FOR MARITIME ARCHAEOLOGY (NMF)

Head of centre: Senior researcher Søren H. Andersen

Facts: established 1993; average annual grant: 10 mill. DKK, present granting period: 1.9 1998-31.8 2003.

*Scientific profil*e: Under the title: "Man and the sea in prehistorical time, medieval time and Renaissance" the purpose of the centre is to contribute to a common cultural-historical conscience which involves the maritime perspective in accordance with the importance it has had in the past, especially in Denmark and Northern Europe.

Location: The National Museum of Denmark.

ECONOMIC POLICY RESEARCH UNIT (EPRU)

Head of centre: Professor Peter Birch Sørensen

Facts: established 1993, average annual grant: 4 mill. DKK, present granting period: 01.09.1998-31.08.2005.

Scientific profile: Macroeconomic research on the European integration, economic policy and micro-based economic models, international trade theory and policy.

Location: University of Copenhagen.

B. Seven original centres that were terminated following international evaluation at the end of the first 5-year period

- Centre for Labour Market and Social Research
- Centre for Semiotic Research
- International Research Centre for Computational Hydrodynamics
- Danish Centre for Remote Sensing
- Centre for Biomolecular Recognition
- Centre for Gene Regulation and Plasticity of Neuro-endocrine Network
- Centre for Enzyme Research

C. More recent Centres not included in the current international evaluation

- Centre for Solid Phase Organic Combinatorial Chemistry (SPOCC)
- Center for Catalysis
- The Danish Center for Earth System Science (DCESS)
- Network in Mathematical Physics and Stochastics (MaPhySto)
- Center for Molecular Plant Physiology (PlaCe)
- Center for Experimental BioInformatics (CEBI)
- Center for Metal Structures in 4 Dimensions
- Center for Nucleic Acid (NAC)
- Centre for Applied Microeconometrics (CAM)
- Center for Biomembrane Physics (MEMPHYS)
- Center for Quantum Optics Laboratory
- The Water and Salt Research Center
- Quantum Protein Centre
- Center of Functionally Integrative Neuroscience
- Wilhelm Johansen Center for Functional Genome Research
- Centre for the Study of the Cultural Heritage of Medieval Rituals
- Centre for Black Sea Studies
- Centre for Subjectivity Research

D. Three centres established in 1998 and terminated after international evaluation by the end of the first 5-year period:

- Center for Plant-Microbe Symbiosis
- Center for Demographic Research
- Center for Human-Machine Interaction

June 2003

APPENDIX 6

PhD students within the 16 centres: 1993-2003

Centre[1]	No. of PhD students	No. of PhD students financed by DNRF	No. of foreign PhD students
SKC	24	6	18
DESC	83	19	14
TAC	30	11	9
ACAP	25	11	2
CAMP	51	14	4
DLC	36	16	14
DCEP	26	11	9
CBS	19	6	3
CMRC	37	9	6
SMI[2]	62	23	41
CSC	18	9	3
CCS	19	7	1
CPC	3	3	0
NMF	19	11	12
EPRU	9	7	0
BRICS[2]	80	30	30
Total	**541 (100%)**	**193 (36%)**	**166 (31%)**

1. Centres are listed in Appendix 1
2. Research schools