

Evaluation of The Danish National Research Foundation



Ministry of Science, Innovation
and Higher Education



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Preface by the Minister of Science, Innovation and Higher Education



The Danish National Research Foundation (DNRF) was established in 1991 with the responsibility of funding research of the highest quality. Now, more than 20 years later, I believe that it was a brave and far-sighted decision. The DNRF has from the inception been guided by a funding model based on trust and long-term investment, which has given Denmark an advantage compared to the rest of Europe where such initiatives have been launched much later.

The foundation was last evaluated in 2003. Ten years is a long time and the supervising authority, the Ministry of Science, Innovation and Higher Education has found it appropriate to conduct another evaluation.

I am very pleased with the evaluation, which in my opinion shows that Denmark has a high-performing science system, which allows us to compete with the best in the world. Moreover, the evaluation recognises the DNRF as being at the core of the Danish research and innovation system. This has been stated by many observers of the Danish system, but now we have a thorough evaluation supporting the claim.

The evaluation discloses that the DNRF has been able to mature during its period of function. It has responded to the recommendations of the evaluation in 2003 and has generally adapted to challenges and opportunities in the research landscape.

As with all successes, we should think ahead and strive towards even better solutions. There is still room for improvements, for example concerning the participation of female researchers as DNRF grant holders and the coverage of some scientific areas in DNRF grants. We need to utilize the full potential of all researchers and I look forward to a continued dialogue on this issue. Also, the DNRF Centres of Excellence attract researchers from all over the world, but there might still be potential for the Centres to further internationalise Danish research. And it is of utmost importance that the foundation stays open to new and risky ideas. The success of the foundation should not lead to stagnation and too much precaution.

In conclusion, I would like to express my sincere gratitude to the panel for taking on the task of evaluating the foundation.

*Morten Østergaard,
Minister of Science, Innovation and Higher Education*

In recent years, the notion of ‘excellence’ and its interconnectedness with the capacity to perform research at the highest level has become extremely popular across Europe. New modes of competitive funding, and in several cases also new funding bodies (like the Agence Nationale de la Recherche in France, or the European Research Council) were established in order to provide more space for risk-taking and some thorough rethinking of common wisdom in order to ultimately achieve more breakthroughs in basic research, scientific and technological development, as well as in product and service innovations.

Given the enormous speed of change in the international division of labour from a world of hands, tools, and machines to one of brains, computing capacities, and laboratories, it is essential to increase the competitiveness of the respective higher education and research institutions; last but not least in view of rapid developments in other parts of the world. The attractiveness of universities and their carefully chosen centres of excellence as reflected in their international visibility and undisputed reputation will be decisive for gaining and maintaining top-talents and creative researchers from anywhere in the world, and for establishing strategically important collaborations.

Much earlier than other European countries, Denmark took on the challenge of establishing a new institution focusing entirely on selecting and supporting excellence in research. As early as 1991, the Danish National Research Foundation (DNRF) was set up with the clear mission to identify and fund outstanding researchers whose performance and leadership qualities provide sufficient promise and potential for future groundbreaking research so that they can be entrusted with medium-, to long-term funding for a newly to be established Centre of Excellence (CoE) at a Danish university of their choice, and thus pursue their research work under optimal conditions at the respective frontiers of knowledge.

These high-trust modes of operation of the DNRF and its CoEs have proven to be extremely successful. Empirical evidence as well as numerous midterm-, and ex post reviews underpin the crucial importance of the DNRF as a catalyst for scientific and scholarly excellence within the Danish research and innovation system. Due to the fact that a large number of PhD students and postdocs is recruited from abroad, it increases the creative capabilities of Danish research institutions quite considerably. The Evaluation Panel therefore strongly recommends to enable the DNRF to continue its impressively successful operations and advises the Danish Parliament to take the necessary decisions for refunding the DNRF in such a way that the capital stock is sufficient to maintain its current annual budget of 400 million DKK in real terms for at least another 10 years.

As Chairman of the Evaluation Panel I should like to express my sincere thanks to my colleagues Suzanne Fortier, Barbara König, Jung-Hoon Chun, and Pär Omling, as well as to Carsten Klein who served so successfully as our academic secretary. Furthermore, I am extremely grateful to all the researchers, representatives of the universities, the other funding agencies and private foundations, the board and the secretariat of the DNRF, as well as the Minister and the staff members of the Danish Ministry for Research, Innovation and Higher Education for their readiness to support us throughout the process, and for their openness in the discussions we had. It has been a great pleasure to work with all of them.

*Wilhelm Krull,
Chairman of the Evaluation Panel*

Since its establishment in 1991, the Danish National Research Foundation (DNRF) has been an important player in the Danish system of research funding. The main focus of the evaluation was on the Centre of Excellence (CoE) scheme and the impact it had on the Danish research system. The key topics addressed were the role of the DNRF in the Danish research funding system, research quality, research training and recruitment, internationalisation, the interaction with host institutions, and the governance and management of the DNRF.

- All in all, the very positive impact the DNRF had on the quality of research in Denmark is remarkable. The DNRF finds unreserved approval from all levels within the Danish research system.
- The orientation towards scientific and scholarly excellence which now characterises the Danish research sector could not have been achieved to this extent without the DNRF and its CoE instrument which is working very well and has created poles of excellence for Denmark which have a strong catalytic effect on universities and research institutions in general.
- One of the success factors is the DNRF's strategy to focus on outstanding talents, to provide them with sufficient funds, a long-term funding perspective, and to grant a far-reaching autonomy with respect to the research agenda and the use of its funds. This enables researchers to venture into novel and often risky projects which may eventually lead to ground-breaking results.
- The DNRF's board is very successful in identifying, nurturing, and supporting talents who are both outstanding researchers and capable centre leaders. However, most of the CoEs have been established in the areas of natural sciences and life sciences, whereas the humanities, social sciences and engineering sciences are underrepresented.
- The CoEs perform high quality research and are internationally acknowledged. This conclusion is substantiated both by the results of the midterm-evaluation of 16 CoEs and by bibliometric analyses.
- Considering the small DNRF-supported part of the Danish research system, a large number of PhD students and postdoctoral scholars (postdocs) are working at CoEs. A large proportion of junior researchers were recruited from abroad, an indication that international students and postdocs regard the CoEs as being highly attractive. A special bibliometric analysis backs the conclusion that the CoEs are very successful in recruiting new talents.
- The CoEs play an important role in the internationalisation of Danish research. The international visibility of the CoEs and the flexibility of the DNRF's funds, which allows them to seize opportunities such as hiring researchers from abroad in a timely manner, are key factors for gaining the best international talents.
- An additional initiative that has allowed top tier recruitments from abroad is the Niels Bohr Professorship scheme, which is highly appreciated by Danish universities. In addition, the DNRF has also entered into joint funding agreements with a number of foundations and organisations from various countries. As far as these agreements are driven by researchers and aim at the establishment of joint centres, they are appropriate means for achieving the aim of collaboration with the best researchers worldwide. However, top-down approaches that not have strategic fits with CoEs should be strongly discouraged.

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- The integration of the CoEs into their host institutions and embedment after the end of funding are working very well in most cases. Faculties and departments are willing to contribute complementary resources to the CoEs and are generally committed to open new positions for some of the respective CoEs' researchers after the funding period. Nevertheless, the continuation of the CoEs' work relies heavily on additional third-party funding. It is the impression of the evaluation panel that the CoEs are successful in most cases in attracting sufficient means from national and European sources in public and private.
 - The panel believes that the outstanding success of the DNRF is closely related to its legal status as an independent foundation, which allows for it to follow scientific and scholarly excellence as the guiding principle and to maintain close relations with the CoEs. Hence, the panel advises strongly against merging the DNRF with the Independent Research Council or other organisations in the Danish funding system.
 - The large one-time investments into the DNRF provide it with flexibility and financial security and make it independent of annual budgets. In order to enable the DNRF to continue its successful work, the Danish Parliament is advised to make the decision of re-funding the DNRF. The capital should be sufficient to maintain the DNRF's current annual budget of at least 400 million DKK (approximately 54 million Euro) in real terms for at least another 10 years.

1.1 Background

The DNRF was set up as an independent body by Act of Parliament in 1991 with the responsibility for funding research of the highest calibre. At its establishment, the DNRF received a start-up capital of 2 billion DKK (approximately 268 million Euro). Following a legislative amendment in 2008, the DNRF received an additional 3 billion DKK (approximately 402 million Euro). The annual level of distribution aims at an average of 400 million DKK (approximately 54 million Euro) corresponding to about two percent of total public research expenditure. Since its establishment, the DNRF has supported Danish research with 6.2 billion DKK (approximately 830 million Euro) primarily through its main funding instrument: the Centre of Excellence scheme (CoE).

The DNRF's activities do not depend on annual appropriation bills. The DNRF enjoys full discretion to manage its funds within the given legal framework, the Ministerial Order on the management of the DNRF's assets. As of March 31, 2013, the DNRF's total assets amounted to 4.0 billion DKK (approximately 536 million Euro), and the annual return on investment since the 2008 amendment to the law has been 6.8%

Under the current financial framework, the last call for new CoEs will be announced in 2015 and the last 10-year CoEs will be established in 2016/17 before the capital of the DNRF will be spent in 2026. The evaluation aims to contribute to providing a basis for taking decisions concerning the future priorities and the future implementation of research funding in Denmark, including the future of the DNRF itself.

1.2 Terms of Reference

On behalf of the Danish Ministry of Science, Innovation and Higher Education a panel of five experts from Europe and North America was asked to evaluate the performance of the DNRF and critically analyse and assess the strategies adopted by the DNRF in its attempts to improve the quality of Danish research.

The evaluation focuses on

- The CoE scheme;
- The organisation of the DNRF;
- The results from research activities, including
 - scientific and scholarly quality;
 - postgraduate education and research training;
 - internationalisation of Danish research;
 - interaction with host institutions during the funding period and embedment of the CoEs in the host institutions after the end of the funding period;
 - application and commercialisation;
- The role of the DNRF in the Danish funding system for research and innovation.

The evaluation has three target groups. The first target group is the political system and the general public who will be informed about the results of investments made in the DNRF. The political system can also use the results to develop future priorities, particularly with respect to research funding at the national level. The second target group is the DNRF board which can use the results to develop future priorities and optimize its approaches to research funding within its mandate. The third target group

are the research institutions which can use the results for strategy and policy development, as a basis to revise the respective strategies for acquiring and hosting CoEs during the funding period, as well as embedding them afterwards.

The evaluation emphasises the CoE scheme, which accounts for at least 85% of the DNRF's portfolio in terms of grants made.

1.3 Methodology

The panel has carried out its analyses from April to November 2013, visiting Denmark three times. The panel met for the first session in Copenhagen on April 26, 2013, having discussions with the Chairperson of the Board, Professor Liselotte Hojgaard, and the Director of the DNRF, Professor Thomas Sinkjær, as well as representatives of the Danish Ministry of Science, Innovation and Higher Education. From August 21 – 23, 2013, members of the panel visited three CoEs at Aarhus University, two CoEs at the University of Copenhagen and one CoE at the Technical University of Denmark.¹ They talked to the Centre Directors, postdocs and PhD students as well as the respective Heads of Department, Deans and representatives of the respective university management. In addition, the panel conducted interviews with the Directors of five CoEs at the University of Southern Denmark, University of Roskilde, and Copenhagen Business School followed by talks with representatives of the management of the University of Southern Denmark, Technical University of Denmark, University of Aalborg, and University of Roskilde. The panel listened to views expressed by previous Centre Directors as well as international members of the DNRF board, and by leading representatives of the Danish Council for Research Policy and the other public Danish funding agencies: the Independent Research Council, the Danish Council for Strategic Research, the Advanced Technology Foundation, and the Danish Council for Technology and Innovation. The review process was complemented by interviews with the management of two large private foundations, the Novo Nordisk Foundation and the Lundbeck Foundation. At its final meeting on November 1, 2013, the panel discussed the draft report and conducted a further interview with the former Chairman of the DNRF Board. All interviewees were explicitly asked to comment on strengths, weaknesses, problems, and opportunities to improve the work of the DNRF.

The DNRF and the Danish Ministry of Science, Innovation and Higher Education provided substantial documentation, which is listed in Appendix 2. These documents included a self-assessment report and a SWOT-analysis by the DNRF. Furthermore, independent bibliometric analyses were conducted to provide additional evidence.

In this report the panel presents its analyses, main conclusions and recommendations as to how the DNRF should proceed in the future. The report has been written independently from the DNRF and the Ministry, and an independent academic secretary has assisted the panel. The DNRF and the Ministry received the draft report and had an opportunity to comment on it. The final version of the report was approved by all the panel members in correspondence and presented to the Danish Minister of Science, Innovation and Higher Education on December 16, 2013.

¹ For a list of the interview partners and CoEs visited by members of the panel cf. Appendix 3.

It is widely recognized that it is essential to provide first-class conditions for teaching, research, and innovation if Europe does not want to be left behind by the world's leading research systems. The speed of change in the international division of labour from a world of hands, tools, and machines to one of brains, computers, and laboratories must be matched by the pace of development in the conditions to be met by internationally competitive universities and research institutes.

With its diverse and complex structures, the field of research and innovation is extremely difficult to be measured and compared. However, there has been a notable tendency throughout the past years to project an increasing relevance onto the results of rankings in this area. The many variables in such comparisons render it extremely difficult to filter and condense the relevant results. The different approaches pursued to reach the common objectives cannot properly be taken into consideration in a one-size-fits-all comparison. Nevertheless, there are undoubtedly some rankings which have established a respectable standard and status in the world of science such as the Times Higher Education or THES World University Ranking and the Shanghai Ranking of World Universities.

In all major rankings of world universities the outstanding performance of U.S. research universities is confirmed. With 7 out of 10 in the THES Ranking 2012/13, and 8 out of the top ten, 17 out of 20, and 52 of the top 100 in the Shanghai Ranking 2013, the leading position of the U.S. top-notch institutions remains largely unchallenged. It is only when one looks at the top 400 in the Shanghai Ranking that Europe with 164 universities surpasses the Americas with 156 top-ranked institutions. The fact that only very few European universities are to be found among the top 50 in the world but 200 among the top 500 reflects the approach traditionally taken in most European countries throughout the second half of the 20th Century. With a predominant focus on broad-based and regionally distributed support for a large number of higher education institutions offering high quality teaching and research, resources were more evenly distributed instead of giving priority to a few research universities enjoying international reputation.

Irrespective of such ranking results, Europe's universities and research institutions compare favourably with the rest of the world in many respects: The European Union is by far the biggest research space on earth. The largest number of academics and also postgraduate students are trained here. European universities confer almost twice as many doctorates as those of the U.S. Europe also produces the highest number of scientific and scholarly publications. But if we look at Europe's share of the world's most frequently cited publications, and above all the numbers of benchmark science awards, including the Nobel Prizes, Fields medals, etc. significant weaknesses emerge. Basically, fewer fundamental breakthroughs are made in Europe. During the last two decades a far greater number of Nobel Prizes and similarly prestigious international awards have gone to scientists working in other parts of the world, notably the U.S. Europe's ability to market basic innovations is comparatively underdeveloped, a situation that has not changed significantly with the recently increased focus on linkages between research and industry, or the Nobel Prizes awarded to European scientists over the last five years.

To keep up with the U.S. and upcoming countries in Asia with respect to research excellence and innovation, the challenge for Europe is to establish and foster a culture of creativity. Creativity certainly is one of the elementary conditions for innovative and successful research work, which may be summarised as follows:

1. **Competence:** The first precondition of successful research is to provide the best training for the future generation of academics and to enable researchers in general to develop their skills freely and in the best learning environment. This is a basic pre-requisite without which no further scientific development appears to be possible.
2. **Creativity:** To achieve excellence in research and innovation creative thought and inspiration are indispensable. Often only considered as a ‘collateral’ side aspect, this is an important component in striving for success. The best conditions should be guaranteed to enable creative and unconventional research projects and thoughts.
3. **Commitment:** Not only researchers, but also the institutional leadership and funders must make proof of their reliable commitment. People, and scientists in particular, can often only be encouraged to enter new fields and leave the beaten track if a certain degree of security is provided.
4. **Communication:** Thought-provoking discussions are essential for achieving progress in research, in particular cross-disciplinary and transcultural exchanges, but also interactions with the outside world. Such communication processes should not regularly be the central aspect of research projects, but their inspirational value should by no means be under-estimated.
5. **Co-operation:** Working closely with partners and informed actors can not only leave a positive impact on one’s own efforts. It can also be an opportunity to engage local and regional actors to benefit mutually and to ascertain a solidly rooted project base. International co-operation is fundamental in modern science and scholarship.
6. **Continuity:** Forging new paths in a barely known territory often takes longer than two or three years, the usual lengths of project funding. Mistakes must be allowed as well as changes of direction, but an overall continuity should be upheld.
7. **Centres:** Research initiatives can be improved by bringing together outstanding experts from similar fields. While this should not result in an isolationist approach, the exchange and merged competence can be a source of stronger results. In times of increasing (international) co-operation, centres and clusters appear a sensible institutional response.

The Nordic countries were among the first countries in Europe that tried to realign their research sectors according to these principles. In Denmark, the DNRF was set up as early as 1991 in order to focus resources on excellent curiosity-driven research and to establish a more flexible model of research funding. The DNRF and its funding instruments, which are focused on the long-term promotion of outstanding researchers under a high-trust regime, have been in many respects a model for the European Research Council (ERC) which was established in 2007. The ERC’s core funding schemes of Starting Grants, Consolidator Grants and Advanced Grants

encourage in particular proposals that cross disciplinary boundaries, thus pioneering ideas that address new and emerging fields, and applications that introduce unconventional, innovative approaches. As the fellows selected are free to choose their host institution anywhere in Europe, their affiliations have become an indicator of the attractiveness of the national research environments. Countries like Switzerland or the UK can boast a high proportion of international grant recipients in their universities whereas the proportion is rather low in countries like Italy and – in view of its research strengths – surprisingly also Denmark.²

On a national level, almost all EU member states followed Denmark in launching new programmes in order to increase competitiveness of their respective higher education and research institutions, to strengthen the science and research sector with particular grants and support mechanisms, and thereby create poles of outstanding achievement or ‘poles of excellence’. An additional objective in many countries was also to trigger reform measures which otherwise would not have been possible.

For instance, in Germany, the ‘Initiative on Excellence’ commenced in 2007. It aims at strengthening Germany as a science and research location, improving Germany’s international competitiveness, and making cutting edge research at German institutions of higher education visible. The total funding volume amounts to 4.6 billion Euros. Funding was offered in three different lines:

- Graduate Schools to promote young researchers and offer them opportunities to prepare for their doctorates;
- Clusters of Excellence to promote cutting-edge collaborative research;
- Institutional Strategies to promote top-level research and to enhance international visibility of the respective universities.

In France, the French National Research Agency (ANR) implemented a major programme called ‘Investissements d’Avenir’ or ‘Investments for the Future’ which was launched at the end of 2009 and enabled research and higher education institutions to gain an additional 21.9 billion Euros. The main focus was on ten-year projects opening up new perspectives and leading to collaborative associations that would otherwise never have existed. Furthermore they are meant to enable not only the financing of large-scale research projects but also the implementation of new infrastructures, research equipment, and the emergence of global research and higher education clusters. The French government also adopted a concept for the ‘Grand Emprunt’ which included a set of reforms for the French university system and opportunities for some of the best French higher education institutions to compete for a dotation in the order of 750 to 950 million Euros and thereby to establish ‘Pôle d’excellence’.

In several other European countries we also find attempts to foster excellence within the respective universities. In Spain, the initiative ‘International Campus of Excellence’ launched by the Spanish Ministry of Education in 2009 aimed at fostering the modernisation and internationalisation of Spanish university campuses. It also focused on teaching, research, and aspects of technology transfer. The ultimate goal in Spain has been almost the same as in other European countries: To achieve greater

2 European Commission: Annual Report on the ERC Activities and Achievements in 2012, p. 44.

international visibility of campuses and to enhance international exchanges of students, academics, and researchers. And in Sweden, the ‘Linnaeus environments’ aimed at enhancing support for research of the highest quality that can compete internationally and supported the respected units for up to ten years.

These recent initiatives on excellence have induced a new dynamic into the European higher education and research environment. The quite substantial additional funds provided have helped to overcome a lot of stumbling blocks with respect to long overdue changes and reforms. However, these initiatives were accompanied by an enormous shift in resource allocation at the universities. Whilst institutional core funding has at best been stagnating, in real terms even reduced, the amount of money distributed through competitive mechanisms such as initiatives on excellence and increasingly through programme approaches has been going up almost constantly at the national as well as at the European level. This has put enormous pressure on researchers to see to it that they can win ever more grants and contracts from funding agencies and industry. In particular during the last five or six years the machinery to earn more grants has reached its limits, and unintended effects come to the fore in large numbers. Time that could better be used to focus on real research work has to be spent on producing ever more proposals and applications, and at the next level all of these applications have to be reviewed by numerous peers. Ultimately the time allotted to most of the grants made is fairly short (usually two to three years) and does not allow tackling the really big, complex research questions. Rather, researchers have to play it safe in order to be able to send in the next proposal just in time for extending the contracts of their co-workers depending on third party funding. As more and more of the soft money available is topically defined through programme approaches, the freedom of topic selection by the researchers themselves is being reduced, and really original thoughts can rarely be found in this realm. Funding schemes like the D NRF’s CoEs which are devoted to long-term funding of independent, curiosity driven research are all the more important. However, they cannot be a substitute for sufficient core funding of the universities.

The Danish research system has recently been subject to a number of examinations. For example, the Royal Swedish Academy of Sciences' report 'Fostering Breakthrough Research'³ provides a comparative study between Sweden, Finland, The Netherlands, Switzerland, and Denmark. In terms of high-impact research, Denmark comes out very well in the analysis. This is consistent with Denmark being placed among a group of four innovation leader countries and ranked as number 3 on the Innovation Union Scoreboard 2013 by the European Union. The Research Barometer 2012, published by the Danish Ministry of Science, Innovation and Higher Education, presents a broad range of indicators which, together, create an overview of the quality and range of Danish research. With respect to the impact of publications, Denmark ranks third out of 38 countries in terms of citations per publications.

The performance of the Danish universities in international rankings aligns with this picture. In the Shanghai Ranking 2013, two Danish universities are in the top 100: the University of Copenhagen on rank 42 and Aarhus University on rank 81; Technical University of Denmark ranks between 151 and 200. In the THES ranking 2012/13, Aarhus University is on rank 116, the University of Copenhagen on rank 130, and the Technical University of Denmark on rank 149.

In 2010, the total expenditure on research and development in Denmark amounted to 55 billion DKK, corresponding to 3% of GDP of which the public sector accounted for 1% (17 billion DKK). Part of the remaining 2% of GDP includes substantial funding of research at public research institutions provided by private foundations and charities. Denmark displays one of the highest percentage shares in the world of public research funded by private donations.

The Danish funding system of research and innovation is highly diversified as shown in Figure 1. The *DNRF* with its focus on elite programmes is only one of several players in the Danish arena of research funding. The major funding agency for the promotion of basic research in Denmark is the *Danish Council for Independent Research (DFI)* which invests approximately 1.2 billion DKK annually in investigator driven research within all research areas. The Council receives a large number of applications with a success rate of about 15%. Although some grants are given for larger research projects, the Council's funding strategy is focused on smaller, individual grants with a duration of 1 – 4 years. The Council's funding is meant to provide the basis for basic research in Denmark and to lay the ground for getting larger grants nationally and internationally. Moreover the DFI offers scientific advice to the Minister of Science, Innovation and Higher Education in all scientific areas.

Until now, three independent funding bodies have been responsible for the promotion of strategic and applied research and innovation. The *Danish Council for Strategic Research (DSR)* is a funding body of both basic and applied research in fields of national priority. Apart from research quality, the applicability of the research for the benefit of society at large has been the main selection criterion. For this reason, future users in business and industry or public institutions have been involved in the projects from the beginning. Themes have differed across the years and have been set by the government. Furthermore, DSR is an advisory body to the Minister of Science, Innovation and Higher Education. The aim of the *Danish National Advanced Technology Foundation (HTF)* was to create growth and employment in Denmark

3 Fostering Breakthrough Research: A Comparative Study, The Royal Swedish Academy of Sciences, 2012.

by supporting activities that transfer knowledge from Danish research institutions to the Danish business community. Collaborations had to involve at least one public research institution and at least one private company. The Foundation focused particularly on nano-, bio-, and information and communication technology. The *Danish Council for Technology and Innovation (RTI)* is an administrative body for initiatives handed to the council by the Minister. These initiatives aim for the promotion of innovation and dissemination of knowledge between knowledge institutions and enterprises. RTI is also an advisory body to the Minister of Science, Innovation and Higher Education on technology and innovation policy issues.

FIGURE 1
The Advisory and Funding System for Research and Innovation



DASTI: Tal om forskning 2012

Source: Danish Ministry of Science, Innovation and Higher Education

In October 2013, the Danish Minister for Science, Innovation and Higher Education announced that the Danish government and other political parties have reached an agreement to establish a new Danish Innovation Foundation by combining the Danish Council for Strategic Research, the Danish National Advanced Technology Foundation, and the Danish Council for Technology and Innovation. The new foundation will have an annual budget of approx. DKK 1.5 billion (201 million Euro). It will be responsible for implementing grants for research, technology development, and innovation, which are based on societal and commercial challenges and needs. Furthermore, the political agreement includes an evaluation of the Danish Council for Independent Research to be completed in 2014.

Apart from public funding agencies, there are 12,000 – 14,000 private foundations in Denmark with an estimated total fortune of over 400 billion DKK. The larger foundations make an especially important contribution to research funding in Denmark. For instance, both the *Novo Nordisk Foundation* and the *Lundbeck Foundation* focus on research funding in biomedicine and biotechnology with a strong emphasis on internationalisation. The Lundbeck Foundation has funded CoEs based on the model of the DNRF and has later changed to strategic grants of 3 + 3 year's duration. The Novo Nordisk Foundation promotes a number of strategic centres that are even bigger than the DNRF's CoEs (about 1 billion DKK for 10 years). The *Carlsberg Foundation* awards grants for basic research in science as well as humanities and social sciences, predominantly to postdoctoral projects. The *Villum Foundation* mainly supports research activities in the natural and engineering sciences, whereas the *Velux Foundation* focuses on some areas of medical research and humanities research projects.

4. The Danish National Research Foundation (DNRF) >

4.1 Objectives and Strategy

The vision of the DNRF is to support frontier research that is potentially groundbreaking and may change the state of the art within its field. To achieve this objective, the DNRF aims at identifying and funding outstanding researchers with ideas that have the potential for scientific breakthroughs.

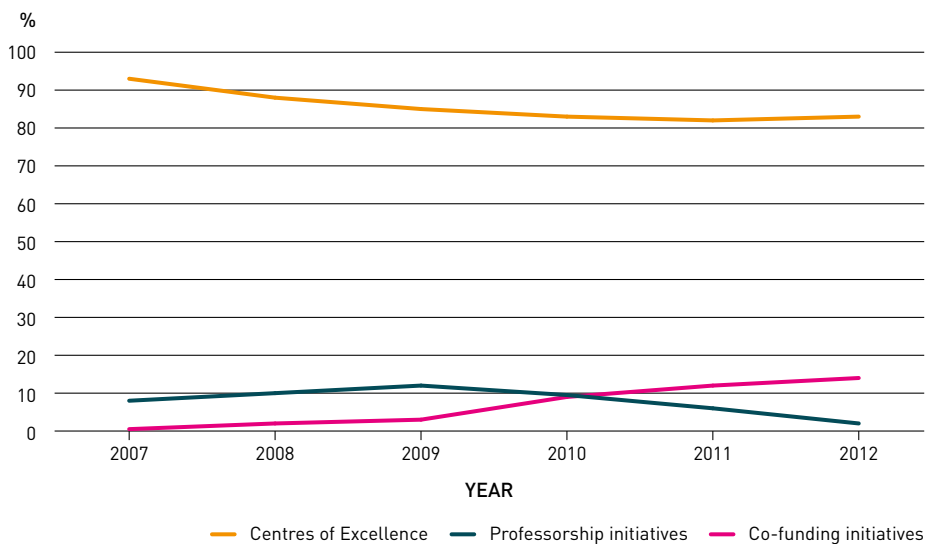
The DNRF has committed itself to three core values:

- *Excellence* should pervade all aspects of the organisation.
- *Trust*: The DNRF's philosophy is that trust stimulates creative research. Accordingly, the talented researchers selected to lead CoEs are given considerable freedom in handling the large and flexible grants at their disposal.
- *Transparency*, fairness, and quality are seen to be the key words in the assessment process. Given the significance of a Centre of Excellence grant, the DNRF feels it to be essential that the scientific community is able to trust the integrity of the DNRF and the assessment and selection processes it uses.

4.2 Funding Instruments

The CoE scheme is the main funding instrument of the DNRF. In addition, a few other initiatives have been launched with the specific goal of fostering the internationalisation of Danish research (see Figure 2).

FIGURE 2
Annual distribution on research activities, 2007-2012 (%)



Source: DNRF

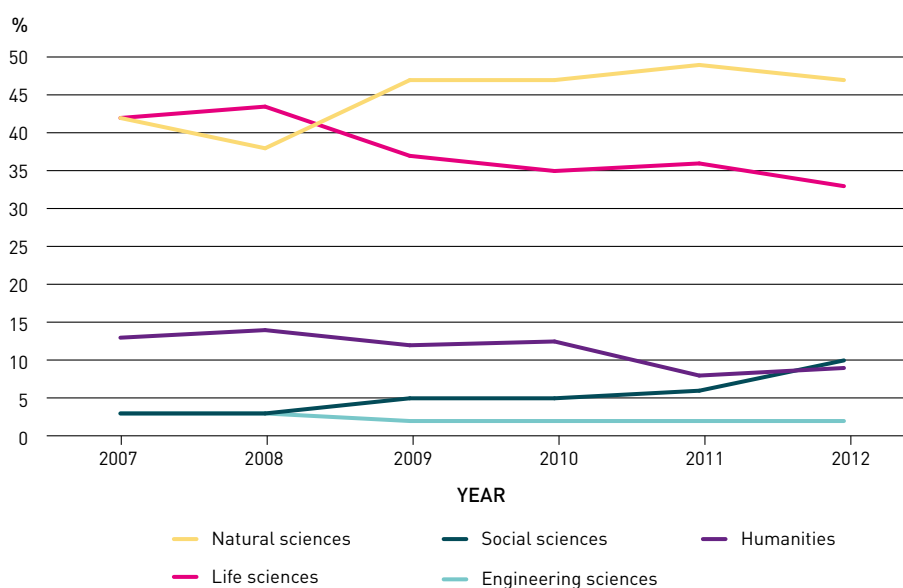
4.2.1. The Centres of Excellence

The CoE programme is the flagship of the DNRF. A Centre of Excellence aims at building a creative research environment and strengthening the exchange of ideas across generations and areas. Many CoEs combine a number of different research fields or disciplines, searching for new insights in the gaps between the traditional disciplines or within emerging areas. In this way, CoEs want to provide excellent training environments for the next generation of researchers. The CoEs try to attract young and talented PhD students and top researchers from Denmark and abroad, and to serve as role models and as inspiration for national and international colleagues. The DNRF intends the CoE programme to remain its main funding mechanism and will continuously monitor, develop, and optimize the programme.

CoEs can be established within and across all research areas. The majority of the CoEs lie in the fields of the natural sciences and the life sciences (see Figure 3). However, the vast majority of the CoEs can be described as cross-disciplinary and, therefore, does not readily fit into the usual categories such as humanities, social sciences, natural sciences, life sciences, and engineering sciences.

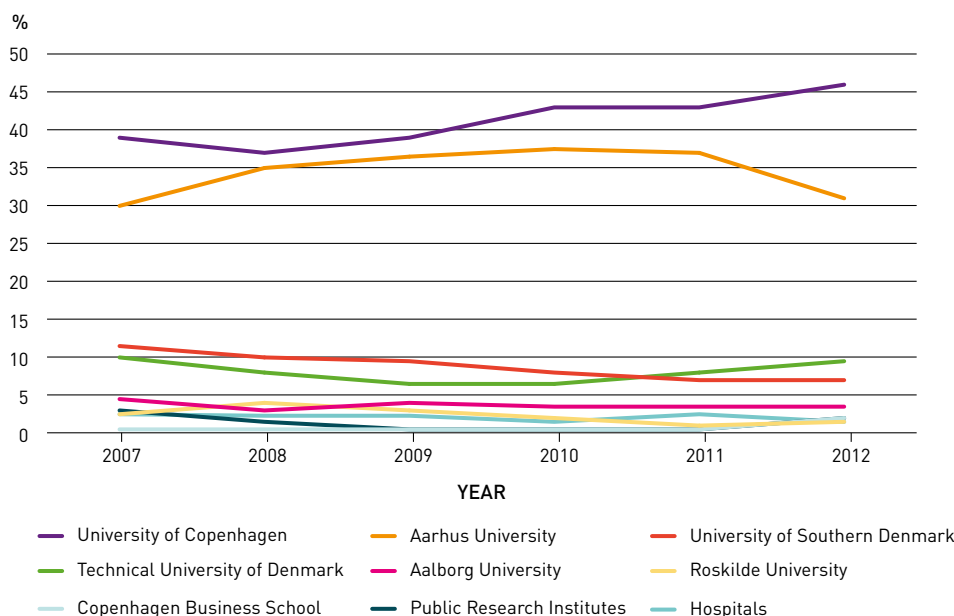
The DNRF states that in the selection of new CoEs it is willing to take risks since in order to achieve cutting-edge and surprising discoveries, researchers and funding agencies alike must venture into novel ways of thinking about the scientific approach and method. The quality and potential of a proposed research idea are the criteria that the DNRF emphasises most in its selection processes. The DNRF also believes that the proposed centre leader is of crucial importance to a centre's success. His or her scientific merits and ability to lead and assemble a team of colleagues with the most relevant competences and profiles are essential. Finally, the envisioned structure of the proposed centre and the nurturing environment in which it is placed play an important role in the selection of new CoEs.

FIGURE 3
Current Centres of Excellence by number and fields of research, 2007-2012 (%)



Source: DNRF

FIGURE 4
Annual distribution by host institutions, 2007-2012 (%)



Source: DNRF

CoEs are seen as individual units or entities with their own distinct identities, but they are established at and co-funded by existing research organisations (primarily universities), where they interact closely with the surroundings. The four biggest universities in Denmark host more than 90% of the CoEs (see Figure 4). The University of Copenhagen and Aarhus University have been particularly successful in obtaining CoE grants. The CoEs play an important role at the host institutions through participation in teaching, training of PhD students and the ability to attract and recruit top researchers and talents from around the world. The CoEs are supposed to have a catalytic effect on their surroundings, and serve as a role model for the host institutions.

In recognition of the fact that heading a Centre of Excellence is a major undertaking, the DNRF has set up a management programme for new centre leaders, which will be continued and further developed. In addition, the DNRF has introduced other platforms on which centre leaders can share experiences, address issues of management, and discuss other relevant topics.

So far, the DNRF has established 88 CoEs with a total amount of 5.4 billion DKK. Of these, 43 are receiving funding from the DNRF, as of April, 2013. CoEs are established in so-called application rounds or competitions. The first application round was in 1992/93. The latest round was the 7th round in 2010/11, when eleven new CoEs were established. An 8th application round has been announced, and a call for proposals was launched in June and remained open until November 25, 2013. The new CoEs from this round will be up and running from January 1, 2015. The next call for new CoEs – the last one under the current financial framework – will be announced in mid-2015.

Calls for new CoEs are announced approximately every two-and-a-half years, and they involve a two-stage application process. In the first stage, prospective centre leaders are invited to submit short outline proposals. In previous application rounds, the DNRF has received between 140 – 200 proposals. All board members assess all proposals prior to the meeting by employing an A – C scoring system with an additional P-score (for Potential) having been added in the 7th application round in order to maintain a focus on proposals that can potentially deliver transformative or groundbreaking results, even though the proposed endeavour may be considered a high risk. Each proposal is discussed at the meeting, and the board formulates a reason for each rejected proposal to be communicated to the applicant.

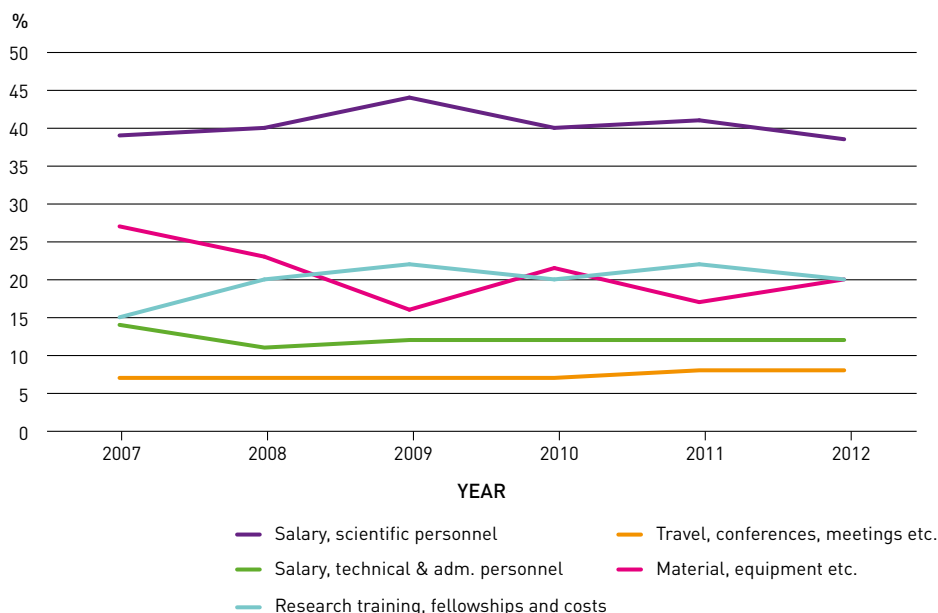
In the second stage, selected applicants submit full proposals. Each full proposal is sent to three high-level international experts within the relevant scientific area(s) for external peer review. Both the applicant and the reviewers are aware of each other's identity. Prior to the final selection, the DNRF board conducts a short interview with each applicant (proposed centre leader).

All applications compete against each other, there is no up-front allocation of the budget to specific areas or disciplines. The overall success rate from submission of outline proposals to establishment of a centre has been 6% in the previous application rounds. 13 – 20% of the outline proposals have moved on from the outline stage one to stage two and about 30 – 40% of those applications have resulted in new CoEs.

Until 2009, CoEs were established for a five-year period with the possibility of an additional five years, provided the centre received a favourable midterm evaluation. Starting with the 7th round of applications (2011), the DNRF decided to change this time structure by extending the first period to six years while maintaining 10 years as the maximum length of a centre's grant. By providing more time in the first period, the DNRF hopes to encourage the CoEs to venture into truly novel and scientifically daring projects that might lead to groundbreaking results.

In the last application round, the average grant for a six-year period amounted to 53 million DKK. However, grant sizes vary considerably within the same application round, depending on the centre's mission and structure. The grants are very flexible, and the DNRF puts a large degree of trust in the centre leader's ability to spend the money best. The centre leaders are charged with fulfilling the research plan. They make decisions on how to spend the funds and are responsible for following the centre budget and for meeting any financial obligations vis-à-vis the host institution. As shown in Figure 5, the funding from the DNRF is primarily used for salaries for temporarily hired staff (PhD students and postdocs) and for equipment, conferences, travels, etc. The DNRF provides funds for the CoEs to hire an administrator or coordinator to assist and relieve the centre leader of some of the administrative and coordination burdens.

FIGURE 5
Annual distributions by categories of expenses, overhead excluded (%)



Source: DNRF

The grant from the DNRF includes an overhead contribution to the host institution(s). Prior to 2008, the overhead rate was 20% of a grant; in 2008, this rate was augmented to 44% according to standard practice for public research funds in Denmark. On the other hand, the host institutions are requested to co-fund the CoEs. This is mainly done by providing salaries for permanent staff. Co-funding from the host institutions accounted for 20% of the total budget for CoEs established in the 7th application round (see Table 1). Agreements regarding co-funding and later embedment of centre activities are made with the host institutions right from the outset. These agreements include not only salaries for current staff members in permanent positions, but may also include a commitment from the host institution of opening new positions within the centre’s area after close down. The contract with the host institution also includes an appendix specifying the minimum space requirements for the CoE including offices, laboratories, and meeting facilities.

TABLE 1
Centers of Excellence by source of finance - first CoE grant period (%)

	2004/05 4th appl. round	2006/07 5th appl. round	2008/09 6th appl. round	2011/12 7th appl. round
DNRF	36	36	40	40
Host institution	28	28	20	20
External funding	36	36	40	40

Source: DNRF

CoEs are evaluated by international evaluation panels twice during the ten-year grant period. A mid-term evaluation is conducted after 5 years (previously 3½ years) by an international review panel, including a site visit to the centre. So far, the prolongation rate has ranged between 55 – 93%. The DNRF takes great care to secure the embedment of PhD students and postdocs into the host institution in case CoEs are not prolonged or are suddenly closed owing to centre leaders exiting before the expiration of the grant. The final evaluation of the 10-year CoEs is conducted about a year before the contract expires by three international experts specifically selected for each centre.

The DNRF is continuously monitoring the CoEs' performance through annual reports. Additionally, in order to stay in close contact with the CoEs, the DNRF visits each centre for annual follow-up meetings and has a continuous dialogue with the CoEs throughout the year.

The DNRF issues a newsletter 3 – 4 times a year for DNRF grant holders as well as present and former board members. The idea of creating a special, common DNRF identity is cultivated at the annual meetings, in which all centre leaders are expected to participate and where they have the opportunity to form networks.

4.2.2. Other Funding Instruments

The DNRF focuses on the CoE initiative and always has had only a few other funding instruments. The DNRF's strategy is to launch new instruments if and when it sees an opportunity to address a particular challenge to Danish research.

The DNRF has launched three professor programmes that share overlapping objectives. In 2005, the *Niels Bohr Visiting Professorships* were initiated with the purpose of promoting the internationalisation and competitiveness of Danish research by attracting top international researchers for repeated stays at existing CoEs in Denmark; 100 million DKK were distributed among six grants in the order of 11 – 21 million DKK each and the initiative ran in the period 2006 – 2011. Most of the six Niels Bohr Visiting Professors stayed in Denmark for six months each year. In 2010, Niels Bohr Visiting Professor Dale Mortensen received the Nobel Prize in Economics.

In addition to this programme, the *DNRF Professor* programme was launched and ran from 2007 until 2012. Its objective was to enrich Danish research by attracting elite international researchers (Danish or foreigners) from abroad to permanent positions in Denmark on favourable terms. The support for this programme amounts to 63 million DKK shared among three grants.

In 2011 the latest professor programme, the *Niels Bohr Professorships*, was launched. This programme can be seen as a merger of the two previous initiatives. A total of six new professorships has been established, and the new Niels Bohr professors will be spending between 50 and 100% of their time in Denmark over the next five years. This programme has been open to top researchers from abroad (Danish or foreigners) and from the outset they have been offered a permanent position at a university in Denmark. The support for this programme amounts to 167 million DKK.

To be more successful in the international competition for the best research talents, the DNRF embarked on a special *Talent Recruitment Initiative* in 2007. The purpose of this initiative was to give the CoEs the opportunity to develop and test new recruiting measures. Many local initiatives have resulted from the talent-recruitment effort. The initiative has not been continued, since most of these activities have now been integrated into the CoEs' general recruitment strategies. The support for this programme amounted to 31 million DKK.

The DNRF has set up *collaborative and joint funding* with a number of large foundations and organisations from various research-intensive nations. Together with the German Max Planck Society, the DNRF co-funded a Centre for Geomicrobiology in 2007 (support until 2012 amounted to 24 million DKK). This centre was awarded a Centre of Excellence grant in the 7th application round and is now funded by the DNRF.

In collaboration with the National Natural Science Foundation of China (NSFC), the DNRF established a joint programme in 2005 which, since 2008, has given rise to 10 Danish-Chinese research centres. The idea behind the programme is to establish contacts between leading researchers from both countries and to support cooperative research projects. The DNRF offers 10 – 15 million DKK to the Danish research centre over a period of three years with the possibility of an extension for a second funding period. The Chinese counterparts are supported by the NSFC. The current agreement with the NSFC runs until 2018, at which time the DNRF will have spent approximately 230 million DKK on this initiative.

Since 2010, the DNRF has collaborated with the National Science Foundation (NSF) in the U.S. on what is now known as the Graduate Research Opportunities Worldwide (GROW) (formerly known as the Nordic Research opportunity, NRO). The programme allows recipients of graduate research fellowships at the PhD level to carry out a research visit at a DNRF CoE for a period of 2 – 12 months. The DNRF spends approximately 1 million DKK per year on this initiative.

The DNRF entered an agreement with the French National Centre for Scientific Research (CNRS) in 2008, and in 2011, the agreement was extended for another four years. The purpose of this agreement is to develop and strengthen scientific cooperation between Danish CoEs and CNRS laboratories and institutes. The programme is intended to accommodate greater mobility between Danish and French research institutes and to promote the exchange of researchers between the cooperating

parties, thereby creating opportunities, especially for younger researchers. Approximately 0.3 million DKK are spent annually.

In its latest addition, the DNRF launched a new programme in 2012 in order to facilitate and stimulate research collaboration with Indian researchers. The DNRF does not work with a specific counterpart in India and supports the Danish-side activities only. The programme will make it possible for DNRF CoEs across all disciplines and with different connections with researchers in India to take advantage of the initiative and enforce a bottom-up approach in defining collaborative activities. So far, three projects have been funded and the DNRF's support amounts to 12 million DKK.

4.3 Governance and Management of the DNRF

The DNRF is governed by a Board of Trustees which consists of nine members. The chairperson and the members are appointed by the Minister for Science, Innovation and Higher Education in their personal capacity. The Minister appoints the chairperson and one other member, while a number of Danish research organisations nominate candidates for the rest of the seats. The board meets six times annually. Board members participate in a number of follow-up meetings in addition to the regular board meetings.

Since the DNRF's beginning, the board has tried to have an international perspective. At first, this international perspective was taken into consideration by appointing Danish professors from U.S. universities and, later on, by appointing foreigners, especially from the Nordic countries. Since March 2010, all board meetings have been conducted in English, allowing inclusion of board members who do not master the Danish language. Extracts of minutes of board meetings, recommendations, etc. have also been available in English since that date.

The secretariat of DNRF is headed by a director with a scientific background. In addition to the director, the secretariat comprises a vice director, 1 senior adviser, 4 research advisers, 1 accountant, 1 secretary, and 1 – 2 student assistants. External consultants are used in matters of asset management, legal advice, etc.

4.4 Evaluation in 2003

The DNRF was evaluated in 2003 by an international peer review panel. The evaluation focussed on an assessment of the outcomes and impacts of the first tranche of CoEs established by the DNRF in 1993/94. The panel came to the following conclusions:

- The CoE initiative has been successful in bringing about genuine improvements to the Danish research system in terms of raising scientific quality, improving research training, and enhancing the internationalisation of Danish science.
- 12 of the 16 CoEs under review have been wholly successful fulfilling DNRF's aims. Of the 16 CoEs, about a quarter have achieved genuine distinction as world leaders in their scientific fields.
- Several of the CoEs had an impressive record in research training. Overall, however, more effort is needed to fulfil the DNRF's research training objective across the board.

- The objective of internationalising Danish science has been achieved unevenly in the CoEs which have been 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 CoEs have demonstrated successful engagement with users or the public generally. The board should do more to encourage outreach activities at CoEs and to maintain an open attitude to proposals for new CoEs with potential for application.
- The panel sympathized with the arrangements for selection, funding, management, monitoring, and evaluation. In particular, it supported the DNRF's policy of not normally funding a CoE for more than two periods of five years.
- The government was advised to give the DNRF longer-term financial stability.
- Opportunities for embedding CoEs in a Nordic and wider European framework should be explored. In its selection procedures, the DNRF should consider giving greater emphasis to international networking and collaboration.
- The future of those CoEs that were nearing the end of their second five-year period of DNRF funding was identified as a major issue. Not all host institutions were willing, or able, to take over the funding responsibility necessary to ensure continuity even in those cases where it would be fully warranted by the excellent quality of the respective Centre.

As a consequence of the evaluation, the DNRF established new instruments aiming at the internationalisation of the Danish research system and also took measures to improve the embedment of the CoEs into their host institutions. In 2008, the DNRF received an additional capital of 3 billion DKK from the Danish Government.

All in all, the evaluation panel in 2013 is deeply impressed with the performance of the CoEs and the positive impact the DNRF has on raising the quality of research in Denmark. It is no exaggeration to state that the orientation towards scientific and scholarly excellence which characterises the Danish research sector could not have been achieved to this extent without the DNRF and its CoE scheme. The DNRF finds unreserved approval from all levels within the Danish research system. In the evaluation panel's experience such a unanimously positive attitude is very unusual.

It became obvious during the evaluation that the DNRF has a unique position in the Danish system of research funding. This is particularly true with respect to the CoE scheme which is working very well and has created poles of excellence for Denmark that have a strong catalytic effect on universities and research institutions in general. One of the success factors clearly is the DNRF's strategy to focus on outstanding talents, provide them with sufficient funds and a long-term funding perspective, and give them a far-reaching autonomy with respect to the research agenda and the use of its funds. This enables researchers to venture into novel and often risky projects that might lead to ground-breaking results. Following this approach, the DNRF has been extremely successful in fostering bottom-up, curiosity driven research in Denmark.

The CoE scheme has inspired new efforts, both by other public and private funding organisations as well as in elite programmes at Danish universities. This clearly indicates that the quality of the DNRF's approach is highly appreciated and widely recognized with respect to its outstanding achievements.

Obviously, the challenge of the DNRF is to identify talents who are both outstanding researchers and capable centre leaders. It is the panel's impression that the DNRF's board is very successful in this respect, although there are differences with respect to the distribution of CoEs across disciplines. Most of the CoEs have been established in the areas of natural sciences and life sciences whereas the humanities, social sciences and engineering sciences are underrepresented. The panel observed that the number of CoEs in the area of life sciences is slightly going down in recent years (see Figure 3). This might be related to the fact that private foundations such as the Novo Nordisk Foundation have recently embarked upon promoting centres in biomedical research with large funding volumes.

Since its founding in 1991, the DNRF has successfully tackled problems such as the embedment of the CoEs into their host institutions. It has clearly acted as a learning organisation throughout its existence.

More specific results of the evaluation are given in the following chapters.

5.1 Research Quality

Although assessing research quality and impact is notoriously difficult, there is clear evidence that the overall performance of the CoEs with respect to research quality is extremely high and widely acknowledged internationally. Furthermore, the panel believes that the CoEs did have an important impact on raising the quality of research in Denmark in general. The evaluation has substantiated the surmise of the report from the Royal Swedish Academy of Sciences that the DNRF has been an important player in raising the international profile of Danish research and that it has been instrumental in assisting Danish universities to direct their research priorities toward academic excellence.

In the 2009 midterm evaluation of the 16 CoEs from the fourth application round, 14 CoEs were extended. As part of this evaluation process the peer reviewers of the 14 successful CoEs were asked to assess whether the centre they had evaluated ranked in the top 5, 10, or 20% globally within their respective research fields. Five of the CoEs were ranked in the top 5% globally, while all the other CoEs were ranked in the top 10%. This assessment confirms and further qualifies a finding of the international panel that evaluated the DNRF in 2003. That panel concluded, based on an assessment of the first 16 CoEs that had completed a 10-year grant period, that about a quarter of the CoEs had achieved distinction as world leaders in their respective fields.

These conclusions are backed up by a bibliometric analysis of publications from CoEs conducted on behalf of the Danish Ministry of Science, Innovation and Higher Education⁴. Since the focus of the analysis was on the DNRF and not on the individual CoEs, the DNRF was treated as a set of publications ('DNRF-publications'). The main focus of the analysis was the proportion of highly cited publications, assuming that they can be linked to excellence in research. In order to provide national and international context for the indicators calculated for the CoE publications, two sets of benchmark units were used for comparison: 1) the CoE's contribution to the national performance of Denmark; 2) 10 European and American universities specifically chosen among the top-performing strata in different fields of the Leiden Ranking. It should be noted, however, that only publications published in journals indexed by the citation database Web of Science were analysed. CoEs with poor publication coverage in the Web of Science, such as CoEs working in the field of the humanities or computer science, or CoEs that have been funded after 2009/10 are excluded from the analysis. Altogether 66 CoEs were included. Furthermore, assigning publications to funding organisations is problematic. This is especially true for the CoEs which have a high proportion of external funding in addition to the DNRF grant. Hence, when counting papers there is a tendency to overemphasise the relative contribution of the CoE's core funding.

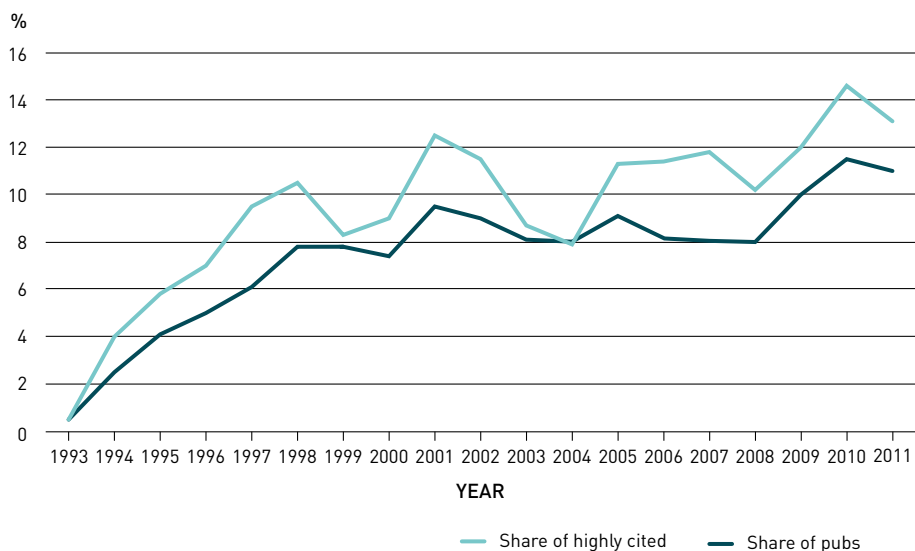
Despite of these caveats, the analysis supports the conclusion that with respect to highly cited publications, the DNRF CoEs perform at a very high level, comparable to the highest-performing universities in Europe, and often better. It can also be concluded that given the relative size of the CoEs, the DNRF-publications contribute notably to the overall Danish impact. More than 20% of the DNRF-publications qualify as highly cited, i.e. among the 10% most cited publications in the database (compared to 14.6% of all Danish publications). For the whole period analysed (1993 – 2011), DNRF-publications constitute about 7% of the Danish publications, and they accumulate 10% of all Danish citations (see Figure 6)⁵.

4 Schneider, Jesper W., Costas, Rodrigo: Bibliometric analyses of publications from Centres of Excellence funded by the Danish National Research Foundation. Report to the Danish Ministry of Science, Innovation and Higher Education, 2013; cf. Appendix 5.

5 Schneider/Costas 2013, p. 28-41.

FIGURE 6

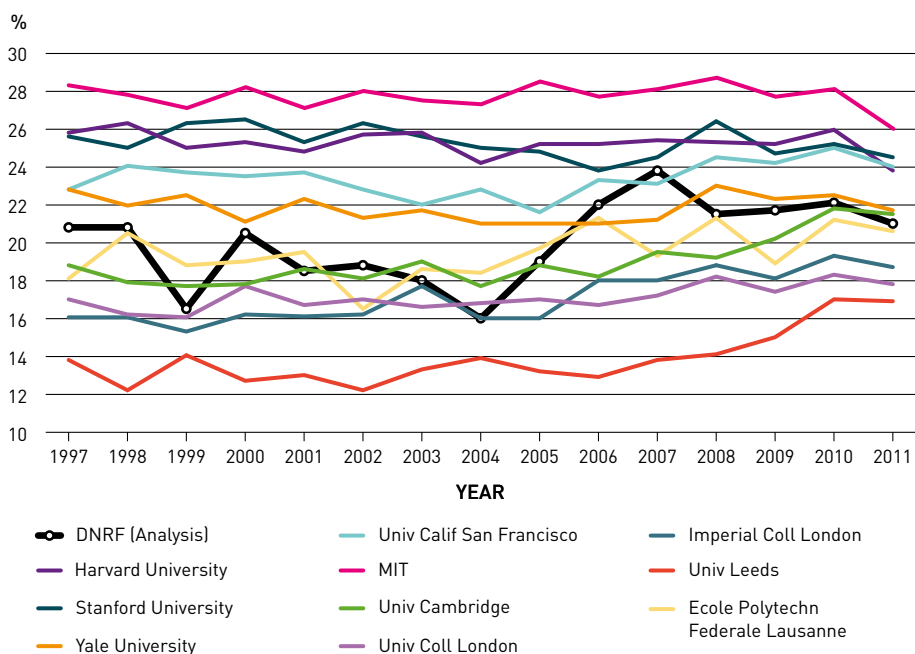
Developments in the annual share of DNRF-publications among Danish and highly cited Danish publications. The threshold for highly cited is the 90th percentile (top 10%)



Source: Schneider/Costas 2013

FIGURE 7

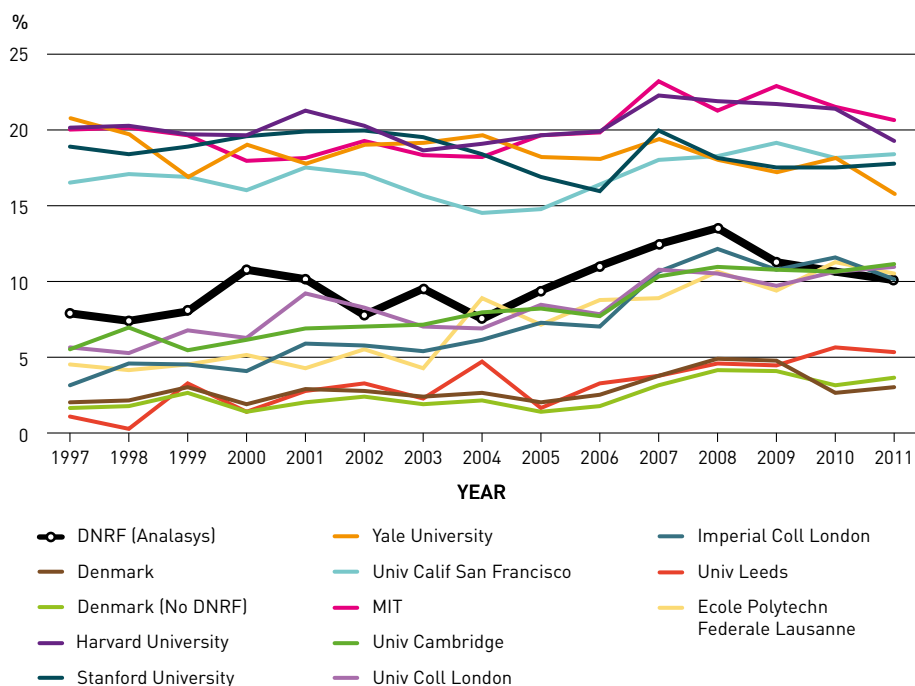
Trend analysis of PP top 10% indicators for DNRF production compared to all benchmark units



Source: Schneider/Costas 2013

FIGURE 8

A trend analysis of the relative share of publications in high impact journals over time for all the units



Source: Schneider/Costas 2013

Comparing the performance to the benchmark universities, the DNRF is ranked in the middle, below the U.S. universities but well above European universities (see Figure 7).

An analysis was also carried out with respect to ‘high-prestige’ journals, which were defined as those journals that have published 30% or more of the top 10% of highly cited publications in their fields in a given year. For the whole period combined, the DNRF-publications have the largest share of publications in ‘high-prestige’-journals compared to the European benchmark universities; again U.S. universities are above (see Figure 8)⁶.

There are annual fluctuations and marked variations in performance between fields and subfields and between individual CoEs. But the DNRF-publication set always performs above the international level and for all fields except the social and behavioural sciences well above the national Danish level.

The long funding periods of the CoEs and the large degree of freedom the centre leaders enjoy in setting up their research agenda are supposed to encourage novel ways of thinking in order to achieve scientific breakthroughs and surprising discoveries. The success of this approach shows up in the respective bibliometric data: the analysis shows that the performance in top-end publications like Science and Nature is particularly good; here the CoEs perform at the same level as the highest-ranking universities in the world, equal to MIT and Stanford University, and even slightly above Harvard University.

⁶ Schneider/Costas 2013, p. 70-73.

A supplementary analysis tried to identify potential ‘breakthrough’ papers coming from a CoE. A breakthrough-paper is defined as a highly cited paper, with an important spread over its own field and also other fields of science which is not a mere follower of other highly cited publications but that has a genuine relevance on its own. The analysis used three distinct ‘breakthrough’ detection-approaches with different degrees of restriction. In all three approaches, there is an overrepresentation of breakthrough-papers from the set of DNRF-supported publications in relation to the total number of DNRF-supported publications. However, these papers are associated with few CoEs, and for many CoEs, only one or no such paper was detected depending on the restrictedness of the approach. Most of the breakthrough-papers can be categorized as research in bioinformatics and nanoscience and, in the least restrictive approach, also in epidemiological research, catalysis, metal structures and sensory-motor research. The three clearly highest ranked CoEs in the impact analysis are also the three most prominent in this breakthrough analysis. In that respect, the breakthrough analysis substantiates the main findings.⁷

Prizes, awards and grants can be seen as another indication of the quality of research. This is particularly true for ERC grants, which are awarded following a highly competitive application, a thorough assessment, and a tough selection process. As to April 2013, Denmark has received a total of 40 starting grants, 10 of which have been awarded to researchers associated with DNRF CoEs. 34 Danish researchers have been awarded prestigious ERC advanced grants. Nineteen (i.e., 56%) of these grant holders received their ERC advanced grant after they became affiliated with a DNRF Centre of Excellence. An additional two ERC advanced grants are held by two DNRF grantees of the Danish-Chinese CoEs.

Apart from ERC-grants, many CoEs have successfully attracted substantial third-party funding from other sources. This includes funding from the Independent Research Council (mainly for postdocs affiliated with the CoEs) and the Strategic Research Council or the Advanced Technology Foundation. Private foundations also frequently support individual centre members as well as research projects within the CoEs. Many CoEs are successful in obtaining EU and other international grants. Having successfully applied for and run a CoE seems to be a good starting point for acquiring EU grants. The prestige and quality associated with being awarded the status of a Centre of Excellence also seems to be an important factor in attracting additional funding.

It should be noted, however, that the ability to attract external funding varies across disciplines. In 2011, the external funding to CoE’s within natural sciences, life sciences, and the engineering sciences double the total funding available as compared to the grant received from the DNRF. Within humanities and social sciences external funding equals approximately 50% of the funds they receive from DNRF.

The panel observed that senior researchers working at CoEs, though officially eligible for application, seem to have little chances to obtain grants from the Independent Research Council. This should be analysed more closely and reflected upon in due course.

7 Schneider/Costas 2013, p. 80-93.

5.2 Research Training and Recruitment

In total, 701 PhD students were affiliated with a DNRF CoE in 2012, funded partly by CoEs and partly by additional funding attracted by the CoEs. In 2011, 8% of all PhD students in Denmark were working at a CoE. Considering the small DNRF-supported part of the Danish research system, this is quite a high number. A large proportion (40% in 2012) of the PhD students is recruited from abroad,. Clearly this is an indication that international students regard the CoEs as highly attractive.

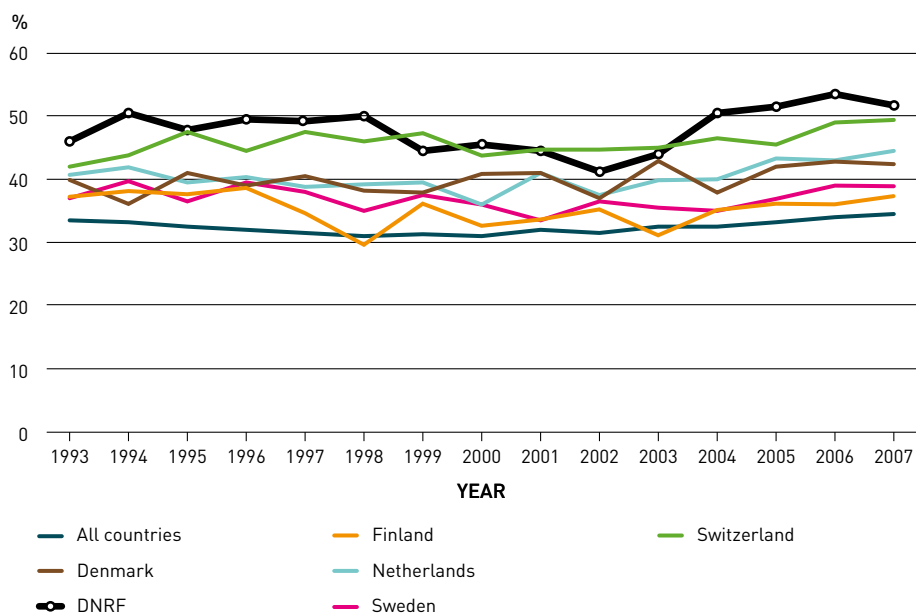
In the interviews conducted with PhD students during the site visits all of them appeared to be highly motivated in their own research and very satisfied with their working conditions. They are able to pursue their research interests independently, and are encouraged to apply for their own grants. Certainly the CoEs provide an ideal framework for talents to grow. Generally there was a sense of privilege in comparison with the PhD students working at the faculties outside a CoE. However, at some universities the international PhD students missed a single contact person which can be addressed for assistance in bureaucratic matters associated with immigration, housing, etc. In most cases, the centre's PhD students were integrated into graduate schools of the respective faculty, with varying satisfaction with respect to the courses offered within these programmes. Dual degrees with universities abroad (e. g. within Eurodoc programmes) would be very desirable but are difficult to obtain in Denmark.

Postdocs constitute another important group of centre members. In 2012 a total of 522 postdocs were affiliated with the CoEs, corresponding to almost 16% of all postdocs in Denmark that year. 62% of these were recruited from abroad. Data from midterm and final evaluations indicate that most of the postdocs continue their careers in academia after leaving the CoEs. About a third of them have remained at Danish universities, while others have moved abroad, largely to the U.S., Germany, the U.K., and Sweden. Many postdocs would like to stay in Denmark but felt that there are only few permanent positions open.

To get an estimate of the success of the CoEs in hiring outstanding talents, a special bibliometric analysis was conducted for this evaluation (see Figure 9).⁸ It tried to find out how many 'successful' new scientists, i.e. scientists who are able to publish at least one highly cited paper within a short time period after their first detectable publication in the Web of Science, were recruited by the CoEs. An annual recruitment rate for DNRF was calculated and compared to five benchmark countries including Denmark. Overall, DNRF has the highest recruitment rate of the six units analysed. The rate for most years is approximately 50%. In general, one in two scientists affiliated to CoEs have been associated with at least one highly cited publication within three years of their first identified publication in the Web of Science. For the whole period, 14.3% of the new scientists identified for Denmark are associated with CoEs funded by DNRF and 17.4% of the 'successful' new scientists in Denmark are associated with DNRF. These numbers indicate that DNRF's CoEs are successful in recruiting new talents.

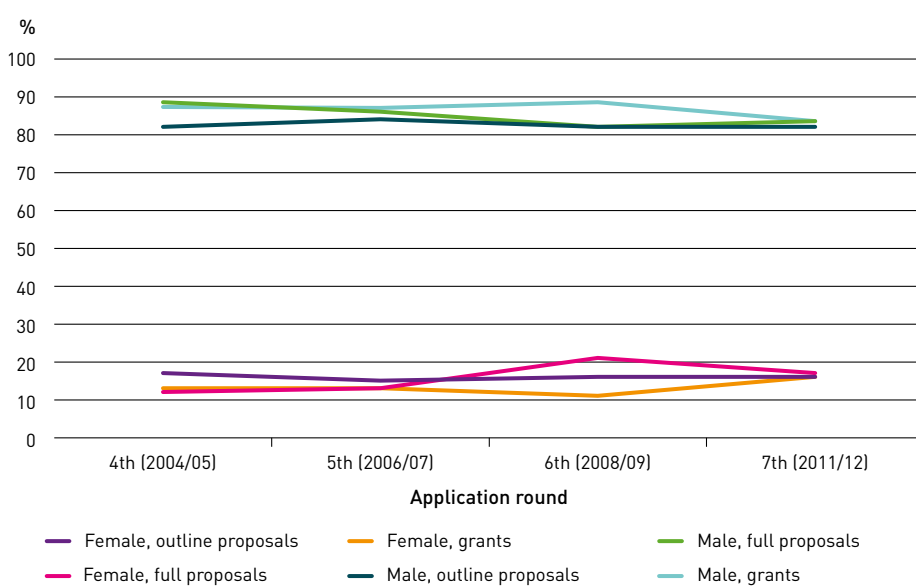
8 Schneider/Costas 2013, p. 74-79.

FIGURE 9
 Development in the rate of 'successful' new scientists within three years from the scientist's first publication in Web of Science



Source: Schneider/Costas 2013

FIGURE 10
 Outline proposals, full proposals and grants by gender of proposed center leader (%)



Source: DNRF

Among the centre leaders, 85% are men (see Figure 10). This matches the distribution in the Danish research system in general, only 16% of all professorships at Danish universities in 2011 were held by female researchers. The DNRF board claims that it welcomes excellent proposals that may lead to new CoEs led by women. However, the panel missed specific measures for the active promotion of women. There seems to be not enough awareness of the gender problem within the Danish research system generally.

5.3 Internationalisation

CoEs attract a large number of foreign researchers, which have been increasing over the last years (see Figure 11). With respect to researchers from abroad, the ratio for faculty members increased from 21% in 2007 to 29% in 2012, the ratio for post-docs from 56% in 2007 to 62% in 2012, and the ratio for PhD students from 21% in 2007 to 40% in 2012. The total number of visiting scientists from abroad increased from 77 in 2007 to 122 in 2011, whereas the ratio of visiting scientists from abroad decreased from 90% in 2007 to 79% in 2012. Although the statistics can only be compared with reservation due to different delimitations, it can be said that the CoEs attract a significantly higher number of foreign researchers than the national average. The ability to recruit researchers from abroad can be regarded as an indication of the quality of the CoE's research and its international visibility. The same can be said for collaborations with partners abroad at research institutions with a global reputation. In 2011, the CoEs collaborated with 1,619 researchers at foreign institutions and with 47 foreign companies. More than 50% of DNRF-publications are produced in the framework of international collaboration.⁹

FIGURE 11
Center members from abroad (percentage of total number)



Source: DNRF

⁹ Schneider/Costas 2013, p. 67.

On the other hand, the proportion of Danish young researchers who spend a postdoc-period abroad is rather low. One reason can be seen in the fact that Danish universities tend to fill their postdoc-positions with PhD students from within.

Following the recommendations of the evaluation panel in 2003, the DNRF took on a number of initiatives specifically targeted at increasing the internationalisation of Danish research at multiple levels. In certain areas, remuneration was identified as a challenge to attract excellent people from abroad. Therefore, the DNRF established two professorship programmes that offered attractive funding options for outstanding international researchers in Denmark. The Niels Bohr Visiting Professorships and the DNRF programme for permanent professorships were merged in 2011 to create the more flexible Niels Bohr Professorships. This scheme is highly appreciated by Danish universities and has allowed excellent recruitments from abroad. Nevertheless, the evaluation panel sees the best instrument for internationalising Danish research in the CoEs themselves. The international visibility of the CoEs and the flexibility of the DNRF's funds which allow the CoEs to seize opportunities of hiring researchers from abroad in a timely manner are crucial for gaining the best talents.

In addition to the professorship programmes, the DNRF has also entered into agreements of joint funding with a number of foundations and organisations from various countries. As far as these agreements aim at the establishment of joint centres and are driven by researchers they are appropriate means for achieving the aim of collaboration with the best researchers worldwide. However, top-down binational agreements that mainly have a political motivation should not be expanded.

5.4 Application and Commercialisation

The CoEs submitted 84 patent applications between 2007 and 2011; 20 patents have been granted in the same period, and 7 spin-off companies have been founded. Unfortunately, these figures cannot be compared directly with the national figures for all public research institutions in Denmark. Taking into account that the CoEs are mainly dedicated to basic research, and that the DNRF does not make the potential for applications a criterion when selecting new CoEs, the numbers seem to be quite satisfactory. However, the evaluation panel is of the opinion that curiosity driven research is the basis for innovation and, therefore, an important part of the innovation chain in its own right. Furthermore, the researchers trained at the CoEs represent a pool of highly qualified personnel for industry. 18% of the postdocs and 30% of the PhD students are going into industry (in Denmark and abroad) after they have been trained at a CoE.¹⁰ Thus, the contribution of the CoEs to innovation should not be assessed by the number of patents or spin-off companies but rather by the quality of its research, talents attracted, and subsequent knowledge transfers.

5.5 Embedment and Interaction with Host Institutions

The 2003 evaluation of the DNRF identified the embedment of the CoEs into their host institutions as a crucial issue. In the first round of funding some of the CoEs were set up as rather separated excellence units, having little or no interaction with their hosts. In some cases the termination of CoEs after the first period of funding was caused by the lack of integration into the universities. The DNRF recognized

¹⁰ The numbers were derived from the self-assessment reports of CoEs for two final evaluations in the 2nd and 3rd application rounds, and three midterm evaluations in the 4th, 5th and 6th application rounds.

this issue and took measures to improve embedment and make sure that the CoEs are an integrative part of the universities. Agreements regarding co-funding and later embedment of centre activities were made part of the formal contracts with the host institutions. These agreements include not only salaries for current staff members in permanent positions but may also include a commitment from the host institution of opening new positions within the centre's area after close down. The annual visits of members of the DNRF board provide an opportunity to discuss smaller problems with the university management and take care of them.

According to statements by both centre leaders and representatives of the universities there are no serious problems with respect to embedment nowadays. Today faculties and departments are willing to contribute complementary resources to the CoEs because they are interested in setting up nurturing environments of excellence at their institutions. It is widely recognized that the CoEs have a strong catalytic effect on the host universities in directing their research priorities toward academic excellence, competitiveness and internationalisation.

Since most of the researchers working at CoEs participate in teaching both at the graduate and the undergraduate level, there is also a spill-over effect to the host institutions in educational activities. The DNRF encourages the CoEs to participate in teaching obligations at the host institutions, and it does not normally accept senior staff to be entirely released from teaching obligations. The panel heard of different experiences with respect to the teaching loads of centre leaders and other senior researchers at the CoEs. Some centre leaders complained about high teaching loads and would appreciate the possibility to use DNRF funds for teaching buy-outs. Other departments seem to be very flexible and leave participation in teaching to the researcher's discretion.

Legally, the host institutions don't have to approve an application from one of their researchers for a CoE. In most cases applications are coordinated with the respective universities, faculties and departments. But there are a few cases where applicants succeeded in acquiring a CoE grant without having a position at the institution. Considering the size and reputation of a DNRF grant, a CoE was never rejected by a university, even if it did not fit into its strategic agenda. This certainly constitutes a risk for the ongoing processes of priority-setting and strategy development of the universities. On the other hand, the bottom-up approach is one of the key success factors of the CoE scheme and should be kept.

The continuation of a centre's scientific work after the end of the 10 years funding period is a crucial issue. The DNRF grant produces a dynamic and highly productive research environment which should not be abandoned. For securing continuous support from their host institutions, it is important that the CoEs are integrated into the overall strategy of the respective university at the end of the funding period. Although the universities generally commit themselves to open new positions for some of the centre's researchers after the end of the funding period, the continuation of the centre's work heavily relies on additional third-party funding. It is the impression of the evaluation panel that the CoEs are successful in most cases in attracting sufficient means both from national and European sources. Private foundations also play an important role in this process. Although they are usually not willing to fund a whole CoE after the end of DNRF funding, they are open to the continuation of successful work with individual and project grants.

Although the evaluation panel did not encounter serious problems with respect to the interaction between CoEs and their host institutions, there seem to be some obstacles that complicate the work of the CoEs. E.g., the fact that the CoEs are highly interdisciplinary sometimes seems to be in conflict with the still prevailing organisational set-ups of the universities according to disciplines.

5.6 Governance and Management

The panel believes that the success of the DNRF is closely related to its legal status as an independent foundation. Although appointed by the government, the DNRF's board is fully independent and responsible for the introduction or modification of funding instruments and the selection of grantees, thus allowing it to follow scientific and scholarly excellence as the guiding principle. The large one-time investments into the DNRF give it flexibility and financial security and make it independent of annual budgets.

Obviously, selecting the members of the DNRF board is of the highest importance. The board has to be open to new research approaches and unconventional methodologies, and last but not least it has to be willing to take risks. The work of the current board has been extremely successful. The panel was particularly impressed by the commitment of the current board members who showed an unusual degree of personal responsibility for the objectives of the DNRF. The panel welcomes the decision of the board to conduct its meetings in English in order to further internationalise it. However, at present the international members are only from Nordic countries.

The small head office of the DNRF, led by its director Thomas Sinkjær, works smoothly, efficiently, and effectively. Due to his career as a high-profile researcher and former leader of a CoE the director is recognised by the scientific community. The DNRF's non-bureaucratic approach is highly praised by Danish researchers.

The selection process for the CoEs seems to work very well. The evaluation did not show any evidence that an additional layer of peer review at an early stage would improve the results.

The close contact of the DNRF's board and administration to the CoEs is another key success factor which is only possible in a small organisation. The system of follow-up meetings is not only of value to the DNRF, providing an opportunity for advice or adjustments, it is also highly appreciated by the centre leaders. Not only do they get advice from experienced board members, but the follow-up meetings also engage the entire centre and thereby strengthen its identity and cohesiveness.

The panel strongly supports the DNRF's decision to change the funding periods of the CoEs from 5 + 5 years to 6 + 4 years. A 'mid-term' evaluation after 3.5 years does not encourage the centre leaders to take up ambitious research projects off the beaten track which often need time before results are being produced. However, some risk of failure may be associated with such ventures, and perhaps it can be expected that fewer CoEs will be continued after the first 6 years as compared to the previous 5 + 5 model.

Centre leaders frequently raise the issue of a possible third funding period. The panel backs the view of the DNRF's board that centre grants should be long term but not permanent. In order to take up new research questions and to promote new talents, funds must be available to establish new CoEs regularly.

5.7 Comments on the DNRF's SWOT-Analysis

Following a request from the evaluation panel, the DNRF performed a SWOT-analysis (see Appendix 4). The panel agrees with the *strengths* identified by the DNRF without reserve. The high impact of the CoE scheme on Danish research in terms of excellence and internationalisation was a clear result of the evaluation. This is also true for the advantages of the current model of the DNRF's governance (small size and close contact to the CoEs, legal form of a foundation, independence of the Board of Trustees).

With respect to the *weaknesses*, the fact that the DNRF's funds are limited and more CoEs could be supported without compromising the level of excellence, the panel feels that considering the distribution of funds to the different public funding agencies in Denmark there is a good balance between basic research funding of the Independent Research Council and the elite funding of the DNRF. The performance of the Independent Research Council will be assessed by an evaluation in 2014.

The reasons for the skewed distribution of CoEs among various disciplines are probably multi-layered. To work in bigger research centres is still alien to many researchers in the humanities. In the panel's opinion, the universities should look into this matter and take measures for bringing the humanities up to working in research collaborations. The design of new funding instruments for bridging the gap between small, individual grants and large grants like the CoEs is not a task for the DNRF but for the Independent Research Council and private foundations. The small number of CoEs in engineering sciences is a problem that should be analysed carefully both by the DNRF and the universities. Since modern engineering needs a theoretical underpinning by basic research, there is probably an untapped potential for more applications for CoEs coming from this discipline.

The gender balance among centre leaders and senior researchers at the CoEs is unsatisfactory. The Danish universities should make better use of the potential of women in science in general, and the DNRF and the CoEs should actively promote qualified women by appropriate measures.

That board members from outside Denmark may not know and appreciate Danish laws and institutional constraints contributes to new and unconventional approaches and, therefore, is not a weakness but a strength.

Social media should be used for the outreach activities of the CoEs in order to address new target groups.

That the DNRF is dependent on injections of new money from parliament in regular intervals is not a weakness in the panel's opinion as long as the refuelling process is transparent and reliable.

The DNRF lists procedural optimizations among the *opportunities*, e.g. with respect to the selection processes. The panel did not find evidence that the selection procedures for the CoEs are in need of amendment. However, there might be some potential for optimization in the review-process at the midterm-evaluations, particularly in recruiting the best researchers for the review panel.

The DNRF plans a new programme of collaborations with leading scientists and institutions around the world. The panel believes that additional measures for the fostering of international collaborations should be implemented within the CoE scheme. The CoEs have proven to be highly attractive places for scientists from

abroad, even for those who bring their own funds. If the DNRF wants to earmark resources for internationalisation, the money should be used to set additional incentives for researcher-driven collaborations at the CoEs or between Danish and foreign centres.

With respect to the uncertainty of future funding listed among the *threats*, the panel advises the Danish parliament to make a decision about future funding of the DNRF in 2014. It is the firm belief of the panel that the DNRF should continue its excellent work in the future. In order to provide the DNRF with long-term financial security, it should be supplied with sufficient capital to retain its current annual budget of at least 400 million DKK in real terms for at least another 10 years.

The independence of the DNRF is an asset that is highly valued by all levels within the Danish research system. Hence, the DNRF should remain an independent foundation and not be amalgamated with the Independent Research Council or other organisations in the Danish funding system.

The D NRF has made an important contribution to the improvement of the Danish research system. The orientation towards scientific and scholarly excellence which characterises the Danish research sector nowadays could not have been achieved to this extent without the D NRF and its CoE instrument, which is working very well and has created poles of excellence in Denmark that have a strong catalytic effect on universities and research institutions in general. The panel has formulated a number of recommendations that are intended to help the continuation and further development of the D NRF's impressively successful work. Whereas most of the recommendations are addressed to the D NRF, some of them are directed at the Danish research sector at large, or the Danish government.

6.1 Recommendations Addressed to the Government

1. In order to enable the D NRF to continue its successful work, the Danish parliament is advised to make the decision on re-funding the D NRF. The capital should be sufficient to maintain the D NRF's current annual budget of at least 400 million DKK in real terms for at least another 10 years.
2. The D NRF should remain an independent foundation and not be fused with the Independent Research Council or any other organisations in the Danish funding system. The advantages of a small organisation, including the clear mission of promoting excellence on all levels, the openness for new ideas and potentially risky projects, lean management, and the direct contact with the CoEs would hardly be possible in a large funding agency with diverse objectives.
3. The legal form of a foundation is an asset of the D NRF and should be kept. The substantial one-time investments into the D NRF have given it flexibility and long-term financial security and have made it independent of annual budgets.
4. Some international scientists and scholars from outside the Nordic countries should be appointed to the D NRF's Board of Trustees.
5. The current funding system of independent, curiosity driven research in Denmark appears to be well balanced. The Independent Research Council also plays an important role since it provides the basis for the elite funding instruments of the D NRF, or the ERC. Its performance will be assessed by an evaluation in 2014.
6. In Denmark, as in many other European countries, the ratio of third-party university funding has reached a critical limit. The government should ensure that in the future sufficient core funding is provided for the universities.

6.2 Recommendations Addressed to the D NRF

7. The commitment of the D NRF to excellence on all levels of its work is the unique characteristic of the D NRF within the Danish system of research funding and should be kept by all means.
8. The original concept of the CoE instrument, 1) to focus on the promotion of scientists and scholars who are both outstanding researchers as well as good research leaders, 2) to ensure that the grant recipients have considerable freedom and time in spending the means at their disposal and 3) to provide large grants, was visionary and should be continued.

9. One of the strengths of the CoE scheme is the willingness to consider unconventional, risky projects and to give young talents a chance, even if they do not have an established position at a university. The DNRF should continue this approach and should not become risk averse in the selection of centre leaders.
10. Although there is a risk that externally funded centres challenge the strategies of the universities, the DNRF should continue to be open to applications that were not approved by the host institutions at the first stage of the application process. However, if the proposals enter the second stage of the selection process, the applicants should be encouraged to seek full support of the respective host institution.
11. The Centre of Excellence scheme should remain the core activity of the DNRF. This initiative also contributes significantly to the internationalisation of Danish research. The Niels Bohr Professorships are a successful additional instrument to recruit excellent researchers from abroad and should be continued. However, the panel feels that further initiatives aiming at internationalisation are not necessary. It recommends not to expand the primarily politically motivated binational agreements with international academies, funding agencies, etc. Instead the money should be used to provide the CoEs with additional incentives for researcher-driven international collaborations and joint international centres.
12. The period of total funding for a CoE should be kept at 10 years. A shorter perspective would be opposed to the aim of this initiative to foster new and potentially risky approaches. A longer perspective would prevent a continuous influx of new ideas and new talents.
13. The success-rate with respect to the continuation of CoEs in the mid-term evaluation is rather high. This might be an indication that most of the risky projects have already been sorted out in the selection process or that risky proposals were not submitted in the first place. The DNRF should consider whether its willingness to promote unconventional, risky projects is sufficiently communicated to the research community in Denmark.
14. The CoEs show diversity for their size, modes of organisation, degree of interdisciplinarity, etc. This flexibility is a strength of the funding scheme and should be maintained. However, it is important that grants are of a size that makes it possible to create an environment with critical mass for excellent research and research education.
15. The humanities, certain fields in the social sciences, and engineering sciences are underrepresented among the CoEs. The panel did not find evidence for a systematic bias against these disciplines in the DNRF's selection procedures. However, the DNRF should discuss whether the selection process and the criteria of excellence that are used are suitable for these disciplines.
16. There were no indications that the selection procedure of the CoEs needs to be changed. The DNRF board is very successful in identifying the best talents. Introduction of peer-review elements in the first stage of selection might lower the chances of unconventional, risky projects in between the established disciplines. However, there might be some potential for optimization in the review-process at the midterm-evaluations, in particular with respect to recruiting the best researchers for the review panel.

17. Although the number of patent applications and patents granted indicates a potential for applications for the research conducted at the CoEs, the DNRF is advised to continue its policy not to make this a criterion when selecting new CoEs. Scientific quality should remain the sole criterion in the selection process, and the CoEs should focus on curiosity-driven research. It is their quality of research which makes the CoEs an essential part of the innovation chain.
18. The DNRF's board and the centre leaders as well as the universities generally should take active measures, such as developing a pipeline for future female leaders, to address the gender problem.
19. The DNRF head office should be lead by a high-profile director who is accepted by the research community also in the future.
20. The management courses for centre leaders are very useful and highly appreciated and should be carried on and further developed.
21. Social media should be used for the outreach activities of the CoEs in order to address new target groups.

6.3 Recommendations Addressed to the Danish Research System

22. Considering the catalytic effect the CoEs have on their host institutions in creating environments of excellence and internationalisation, the universities are strongly advised to continue their support for the CoEs by contributing complementary resources and by committing themselves to open new positions for some of the centre's researchers after the end of the funding period.
23. Despite of the legitimate concerns of the universities that newly established CoEs should fit into the institution's overall strategy, the universities are advised to be open to bottom-up initiatives that result in applications for CoEs.
24. The panel does not recommend a new funding instrument for humanities or social sciences under the auspices of the DNRF. The bridging of the gap between small, individual grants and large grants like the CoEs is a task for the Independent Research Council. Private foundations like the Carlsberg Foundation and the Velux Foundation can also contribute to the aim of bringing up these disciplines to working in medium to large research collaborations.
25. Senior researchers working at CoEs should not be put at a disadvantage when applying for a grant at the Independent Research Council.
26. The number of Danish young researchers who spend a longer period of time abroad is rather low. To encourage the mobility of young researchers, the Danish universities should not employ postdocs who have been PhD students at the same institution if they did not spend a substantial period of time at a different institution.
27. In order to attract even more international PhD students, the Danish universities should make possible dual degrees with universities abroad (e.g., within Eurodoc programmes).
28. At the CoEs visited by the evaluation panel, most of the PhD students were integrated into graduate schools at the respective universities. As a rule, the universities should consider to integrate their PhD students into graduate schools.

1. Members of the Evaluation Panel
2. Documentation Available to the Panel
3. Interview Partners and Centres of Excellence Visited by Members of the Evaluation Panel
4. SWOT-Analysis by the DNRF
5. Appendix 5: Schneider, Jesper W., Costas, Rodrigo: Bibliometric analyses of publications from Centres of Excellence funded by the Danish National Research Foundation. Report to the Danish Ministry of Science, Innovation and Higher Education, 2013

Appendix 1: Members of the Evaluation Panel



Dr. Wilhelm Krull, Secretary General of the Volkswagen Foundation, Hannover, Germany (chair).

Dr. Jung-Hoon Chun, Director of the Laboratory for Manufacturing and Productivity and Professor of Mechanical Engineering, Massachusetts Institute of Technology (MIT), Cambridge, MA, USA.

Dr. Suzanne Fortier, Principal and Vice-Chancellor of McGill University, Montreal, Canada.

Dr. Barbara König, Managing Director of the Institute of Evolutionary Biology and Environmental Studies and Professor of Zoology, University of Zurich, Switzerland.

Dr. Pär Omling, President of the European Science Foundation (ESF) and Vice-President of Science Europe, Professor at Lund University, Sweden.

Academic Secretary

Dr. Carsten Klein, Head of Communications and Strategy, Deutsches Museum, Munich, Germany.

Documentation Provided by the Danish Ministry of Science, Innovation and Higher Education

- Terms of Reference for the Evaluation of the DNRF.
- Methodology Brief on the Evaluation Design.
- Presentation of the Ministry of Science, Innovation and Higher Education at the first meeting of the evaluation panel, April 2013.
- Note on the DNRF Self-Assessment 2013.
- Research Barometer 2012 (Summary).
- Bibliometric Analyses of Publications from Centres of Excellence Funded by the Danish National Research Foundation. Report to the Danish Ministry of Science, Innovation and Higher Education, Jesper W. Schneider & Rodrigo Costas, 2013.
- Consolidated Act on the Danish National Research Foundation, 13 August 2008.
- Royal Decree on the Charter of the Danish National Research Foundation, 8 September 2008.
- Comments on the Draft Evaluation Report, November 2013.

Documentation Provided by the DNRF

- Evaluation of the Danish National Research Foundation Centres of Excellence, Report of an International Panel, June 2003.
- Reaching for the Stars: Strategy for the Danish National Research Foundation, December 2010.
- 20 Years of World-Class Research, 2011.
- Curiosity pays off – a presentation of eight Centres of Excellence whose ground-breaking research has engendered a significant commercial activity, 2013.
- Presentation of the DNRF at the first meeting of the evaluation panel, April 2013.
- Danish National Research Foundation, Self-Assessment 2013.
- Statistics of 40 CoEs regarding publications and other performance indicators.
- 18 Evaluation reports for continued centres (mid-term and final), including the CoEs visited by members of the evaluation panel.
- Annual status reports from CoEs where there was no mid-term or final report available.
- Self-evaluation reports of three CoEs.
- Midterm reports or summaries from discontinued CoEs.
- Standard centre contracts.

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- Contracts with the CoEs that were visited by the evaluation panel (partly in Danish).
 - Rules of Procedure of the Board of Trustees of the DNRF, September 2008.
 - The Board's Catalogue of Experiences re: the Centre of Excellence Instrument, February 2012.
 - Mandate of the Executive Board with respect to the management of the foundation's assets as adopted by the board on December 2, 2011.
 - Guide for Applicants in the 8th application round for new CoEs, June 2013.
 - Terms of Reference for evaluation of proposals for new CoEs in the 8th application round.
 - Standard agenda for follow-up meetings at the CoEs (including questions for PhD students, postdocs and guest scientists).
 - Best practise advice got from CoEs at follow up meetings in 2011/12.
 - Guidelines for the scientific annual report.
 - Guidelines and Terms of Reference for the midterm evaluation of the centres established in 2009 and 2010.
 - Guidelines and Terms of Reference for the final evaluation of centres funded by the DNRF 2001-2011.
 - Call for Niels Bohr Visiting Professorships, 2005.
 - Call for Niels Bohr Professorships, 2011.
 - Overview of Niels Bohr Visiting Professorships established in 2006/2007 and Niels Bohr Professorships established in 2013.
 - Call for DNRF Professorships, 2006.
 - Overview of DNRF Professorships established in 2007.
 - Calls for Danish-Chinese Research Centres for all four application rounds.
 - Overview of Danish-Chinese Centres.
 - 15 Newsletters of the DNRF, 2007 – 2012.
 - Annual Reports of the DNRF, 2000 – 2012 (in Danish).
 - Letter from DNRF, July 12, 2013 following up on first meeting and the panel's request for further information from May 13, 2013.
 - Comments of the DNRF on the Draft Evaluation Report, October 2013.
 - Additional data on Internationalisation and staff in DNRF's funding instruments, November 2013.

Other Documents

- Fostering Breakthrough Research: A Comparative Study, The Royal Swedish Academy of Sciences, 2012.
- Innovation Union Scoreboard 2013, European Union.
- The Danish Council for Independent Research, Annual Report 2013 (in Danish).
- The Danish Council for Research Policy, Annual Report 2007 (in Danish).
- Private fonde – en unik aktør i dansk forskning, The Think Tank DEA, 2012 (in Danish).
- Letter by Per Holten-Andersen, President of Copenhagen Business School, to the Evaluation Panel, August 2013.
- Comment on the Centre for Labour Market and Social Research, Aarhus University, by Svend Hylleberg, Dean of the School of Business and Social Research, Aarhus University, September 2013.

Appendix 3: Interview Partners and Centres of Excellence Visited by Members of the Evaluation Panel



CoEs visited by members of the panel and interview partners at the respective CoEs

Centre for Insoluble Protein Structures (INSPIN), Aarhus University

- Professor Niels Christian Nielsen, Centre Leader
- Professor Brian Bech Nielsen, Rector of Aarhus University
- Professor Jes Madsen, Vice-Dean of Science and Technology, Aarhus University
- PhD students and postdocs

Centre for Carbohydrate Recognition and Signalling (CARB), Aarhus University

- Professor Jens Stougaard, Centre Leader
- Professor Knud Jørgen Jensen
- Associate Professor Simona Radutoiu
- Professor Niels Christian Nielsen, Dean of Science and Technology, Aarhus University
- Professor Erik Østergaard, Head of Department of Molecular Biology and Genetics, Aarhus University
- PhD students and postdocs

Centre on Autobiographical Memory Research (CON AMORE), Aarhus University

- Professor Dorthe Berntsen, Centre Leader
- Professor Peter Krøjgaard
- Professor Ocke Bohn
- Professor David C. Rubin
- Professor Svend Hylleberg, Dean of the School of Business and Social Sciences, Aarhus University
- PhD students and postdocs

Centre for GeoGenetics, Natural History Museum of Denmark, University of Copenhagen

- Professor Eske Willerslev, Centre Leader
- Senior researcher Tom Gilbert
- Senior researcher Ludovic Orlando
- Professor John Renner, Dean of the Faculty of Science, University of Copenhagen
- Professor Kurt H. Kjær, Head of Research, Natural History Museum of Denmark, University of Copenhagen
- PhD students and postdocs

Centre for Textile Research (CTR), University of Copenhagen

- Professor Marie-Louise Nosch, Centre Leader
- Associate Professor Eva Andersson Strand
- Senior researcher Ulla Mannering
- Guest Professor Mary Harlow, University of Leicester
- Professor Ulf Hedetoft, Dean of the Faculty of Humanities, University of Copenhagen
- Professor Anders Holm Rasmussen, Director of The SAXO-Institute – Archaeology, Ethnology, Greek & Latin, History, University of Copenhagen
- PhD students and postdocs

**Centre for Individual Nanoparticle Functionality (CINF),
Technical University of Denmark**

- Professor Ib Chorkendorff, Centre leader
- Associate Professor Sebastian Horch
- Associate Professor Jakob Schøitz
- Professor Ole Hansen
- Professor Jane H. Nielsen, Head of Department of Physics,
Technical University of Denmark
- PhD students and postdocs

Additional Interview Partners

Centre Leaders

- Professor Donald Eugene Canfield, Nordic Centre for Earth Evolution,
University of Southern Denmark
- Professor Jeppe C. Dyre, Centre for Glass and Time, University of Roskilde
- Professor David Lando, Centre for Financial Friction,
Copenhagen Business School
- Professor Lars Boje Mortensen, Centre for Medieval Literature,
University of Southern Denmark
- Professor Francesco Sannino, Centre for Particle Physics Phenomenology:
CP3-Origins, University of Southern Denmark

Former Centre Leaders

- Professor Søren Brunak, Leader of the Centre for Biological Sequence
Analysis (CBS), Technical University of Denmark, 1993 – 2003
- Professor Sine Larsen, Leader of the Centre for Crystallographic Studies (CCS),
University of Copenhagen, 1993 – 2003
- Professor Birger Lindberg Møller, Leader of the Centre for Molecular
Plant Physiology (PlaCe), The Royal Veterinary and Agricultural University,
1998 – 2008
- Professor Leif Østergaard, Leader of the Centre of Functionally Integrative
Neuroscience (CFIN), Aarhus University, 2001 – 2011
- Professor Jesper Wengel, Leader of the Nucleic Acid Centre (NAC),
University of Southern Denmark, 2001 – 2011
- Professor Dan Zahavi, Leader of the Centre for Subjectivity Research (CSR),
University of Copenhagen, 2002 – 2012

Management of Danish Universities

- Professor Finn Kjaersdam, Rector, Aalborg University
- Professor Henrik Pedersen, Dean of the Faculty of Science,
University of Southern Denmark
- Professor Ib Poulsen, Rector, University of Roskilde
- Professor Henrik Wegener, Provost, Technical University of Denmark

Members of the DNRF Board

- Professor Liselotte Højgaard, Chairperson of the Board
- Professor Klaus Bock, Chairman of the Board until December 31, 2012
- Professor emeritus Eivind Hiis Hauge, Norwegian University of Science and Technology (NTNU), Member of the Board
- Professor Gunnar Öquist, Umeå University, Sweden, Member of the Board until October 31, 2013

The DNRF Head Office

- Thomas Sinkjær, Director

The Danish Council for Research Policy

- Claus Hviid Christensen, Chair
- Professor Marie-Louise Nosch, Vice-Chair

The Independent Research Council

- Professor Peter Munk Christiansen, Chair
- Professor Merete Fredholm, Vice-Chair

The Danish Council for Strategic Research

- Peter Olesen, Chair

The Danish Council for Technology and Innovation

- Annette Toft, Vice-Chair

The Danish National Advanced Technology Foundation

- Carsten Gaarn-Larsen, Managing Director

Private Foundations

- Anne-Marie Engel, Director of Research, The Lundbeck Foundation
- Birgitte Nauntofte, CEO, Novo Nordisk Foundation

Strengths

- The Centre of Excellence (CoE) as the primary funding instrument, fine-tuned over 20 years. The instrument has had a high impact on Danish research in terms of top-notch researchers, internationalisation and education. Boost of midterm career scientists, thereby fostering outstanding talents and future leaders.
- Focus on excellent people and novel ideas.
- Demanding research questions are addressed by teams of researchers with complementary knowledge (often interdisciplinary). This leads to the potential for breakthrough research that may result in societal change.
- Flexibility in the size of centres and the use of grants. Funding for up to ten years allows for the creation of truly new and challenging research programmes.
- Catalytic effect on universities and research institutions, building both creative and competitive environments.
- Transparent processes build trust in research communities. Close and ongoing dialogue between the board, the secretariat, the CoEs, applicants and other relevant agents in research policy and financing.
- A dedicated and committed board takes full responsibility for funding decisions. The composition of the board is balanced in terms of nationality (Danish and international), research expertise and gender.
- The DNRF is an agile, non-bureaucratic organisation with a small, efficient, and professional secretariat.
- Having its own capital allows the DNRF to engage in long-term planning.

Opportunities

- Develop and exploit the full potential of all talent, male and female, within all research fields.
- Be proactive when needed and the first mover in tackling challenges to Danish research excellence.
- Further strengthen interdisciplinary efforts across borders (departments, faculties, institutions, nations).
- Experiment with optimizing procedures such as external peer reviews, follow-up meetings, and the size and length of grants.
- Develop a new, non-bureaucratic, globally oriented programme with leading scientists and institutions around the world, i.e. to be announced in collaboration with the Innovation Centres and science and education attachés.
- Strengthen the DNRF's good relations with private foundations that support excellent research.
- Use new media forms, e.g., Twitter, Facebook and other social media.
- English as the language of the board allows for the recruitment of board members of high standing from outside the Nordic countries.

Weaknesses

- Excellent research proposals have to be rejected due to limited funding.
- 50-100% more CoE proposals could be supported without significantly compromising the level of excellence, if funding was available.
- Denmark may lose talented researchers. Due to insufficient career opportunities in Denmark, excellent Danish researchers trained at the CoEs may choose to continue their careers abroad.
- There is a skewed distribution of supported institutions and research areas (particularly within humanity, social science and technology).
- The gender balance among centre leaders and senior researchers in general is unsatisfactory.
- Board members based outside Denmark may not know and appreciate Danish laws and institutional constraints.
- There is no use of social media. The foundation's current PR strategy may not sufficiently reach new generations of potential applicants.
- The DNRF is dependent on injections of new money from Parliament at regular intervals.

Threats

- Curtailing the Danish research funding system through a possible merger of the DNRF with other organizations.
- A changing research landscape may jeopardize the foundation's autonomy and its ability to act with the necessary flexibility.
- Earmarking more/all research funds toward specific targets.
- Undermining the necessary renewal of research that builds on the efforts of curious individuals who ask demanding questions.
- The uncertainty of future funding.

Appendix 5: Bibliometric analyses of publications from Centres of Excellence funded by the Danish National Research Foundation



http://fivu.dk/en/publications/2013/files-2013/appendiks-5_bibliometrisk_report_03122013.pdf/view

