



Future choices for the Swedish research system

Knowledge, quality and integrity

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Foreword

In this report, the Swedish Research Council presents challenges and ways forward for the Swedish research system. The report is based on the report *Direction to the Future Swedish Research System* published in 2015, and is intended to constitute underlying documentation for the Swedish Research Council's upcoming work and input into Sweden's research policy, and for a broad discussion about the importance of research, and how it is best conducted and funded.

The report has been produced by a team representing all departments of the Swedish Research Council, in close collaboration with the Swedish Research Council's director general, executive council, board, scientific councils, councils and committees. Subject specialists within the agency have also contributed. A large number of analyses, investigations and reports conducted by the agency and by others have formed the basis for the report. Particularly worthy of mention are the research reviews produced by the Swedish Research Council's scientific councils and committees in 2018, the Swedish Research Council's *Guide to Infrastructure 2018*, and the Swedish Research Council's *Swedish Research Barometer*.

The introductory section, *Future choices*, describes the twelve principal viewpoints of the report. Each of these are then developed further in thematic chapters, where the challenges, the role of the Swedish Research Council and the way forward are described and justified. The introduction to the report describes the general situation for Swedish research, and the problems that give rise to the future choices proposed.

From the Swedish Research Council's side, we are looking forward to future discussions, and of course to concrete measures based on *Future choices for the Swedish research system 2019*. We are convinced that this will energise the Swedish research system in the right direction.

Stockholm, 29 April 2019

Agneta Bladh

Chairman of the Board, Swedish Research Council

Sven Stafström

Director General, Swedish Research Council

Swedish summary: Vägval

En övergripande målsättning inom svensk forskningspolitik har länge varit att Sverige ska vara ett av världens främsta forsknings- och innovationsländer och en ledande kunskapsnation. Utgångspunkten är att högkvalitativ forskning, innovation och högre utbildning på ett grundläggande sätt bidrar till samhällets utveckling och välfärd, näringslivets konkurrenskraft samt svarar mot de samhällsutmaningar vi står inför, både i Sverige och globalt.

Sverige satsar också sedan många år mycket på forskning och utveckling med omfattande FoU-utgifter i relation till BNP. I internationell jämförelse är Sverige dessutom ett land med en hög andel forskare, en hög andel vetenskapliga publikationer per invånare och en befolkning med högt förtroende för forskning. Trots det har Sverige relativt sett tappat mark när det gäller forskningens kvalitet. Här står Sverige således inför ett antal utmaningar.

Vetenskapsrådet har valt att sammanfatta dessa utmaningar i tre övergripande ledord som vägval för en framtida svensk forskningsstrategi: *Kunskap, kvalitet och integritet*. Forskning är och ska vara utgångspunkten för den kunskap och kunskapsuppbyggnad som ska ligga till grund för samhällets utveckling och välfärd, näringslivets konkurrenskraft och lösningarna på de samhällsutmaningar vi står inför. Men för att nå de forskningspolitiska målen måste vi se till att all forskning håller hög kvalitet och att excellens prioriteras. Den enskilda forskarens integritet och frihet är här en grundförutsättning både för att stärka kvaliteten i svensk forskning och för nya kunskapsgenombrott. En grundläggande samsyn om god forskningssed och ökad transparens är avgörande för att bibehålla och stärka samhällets höga förtroende för forskningen och forskarna.

För att befästa Sveriges roll som ledande kunskapsnation och bli ett av världens absolut främsta forsknings- och innovationsländer behövs inte bara en fortsatt satsning på forskning och kunskapsuppbyggnad. Det krävs också åtgärder för att stärka kvaliteten på den forskning som utförs vid Sveriges universitet och högskolor. Samtidigt måste såväl forskarnas integritet som tilltron till forskningen värnas.

Med utgångspunkt i dessa ledord för svensk forskning har Vetenskapsrådet identifierat tolv punkter som är särskilt angelägna för ett svenskt forskningssystem i världsklass:

1. **Forskarinitierad forskning och fria forskare:** Fria forskare och fri nyfikenhetsdriven forskning utgör fundament för ny kunskap, innovation och samhällets utveckling. För att skapa förutsättningar för samhällets långsiktiga utveckling måste det fria forskningsstödet stärkas och fördelas utifrån forskningens kvalitet, sakkunnigbedömd i nationell eller internationell konkurrens.

2. **Externfinansiering och basfinansiering:** Externfinansiering behövs för att driva utvecklingen av svensk forsknings kvalitet. Basfinansieringens huvudsakliga mål ska vara att ge de bästa forskarna bättre, mer långsiktiga och stabila villkor. Samspel mellan basanslag och statlig extern finansiering förutsätter en tydlig rollfördelning och en tydlig bild av hur de olika medlen används.
3. **Forskningsinfrastruktur:** Avancerad forskningsinfrastruktur är i många fall en förutsättning för att kunna bedriva forskning av högsta kvalitet. För att förbättra tillgången till forskningsinfrastruktur bör Vetenskapsrådet få ökade resurser för att bibehålla och förstärka sin roll som ansvarigt för prioritering, samordning och finansiering av forskningsinfrastruktur.
4. **Framstående forskningsmiljöer:** Goda och kreativa forskningsmiljöer är en viktig faktor för att bedriva forskning av hög kvalitet och för att binda samman forskning, utbildning och övriga samhället. Huvudansvaret för att bygga upp forskningsmiljöer är lärosätenas, samtidigt som extern finansiering utgör ett viktigt komplement. Lärosätena bör i högre grad samarbeta för att skapa de bästa förutsättningarna för starka forsknings- och utbildningsmiljöer.
5. **Strategiska forskningssatsningar:** Strategiska forskningssatsningar utgör ett viktigt komplement till den fria nyfikenhetsbaserade forskningen. Regeringen bör ge Vetenskapsrådet i uppdrag att inrätta ett nytt råd för strategisk forskning, med uppgift att föreslå områden för strategiska forskningssatsningar.
6. **Utvärdering och kvalitetssäkring:** Utvärdering av forskningens resultat driver kvalitet. För att svensk forskning ska uppnå högsta vetenskapliga kvalitet måste all forskning sakkunniggranskas. Utvärderingar som utförs av lärosätena och nationella aktörer bör genomföras så att de kompletterar varandra.
7. **Internationalisering:** Att forskare vid svenska lärosäten deltar i internationella samarbeten och sammanhang är avgörande för svensk forsknings kvalitet och utveckling. Sverige bör utveckla samlade nationella strategier för internationalisering som omfattar såväl utbildning som forskning.
8. **Karriärvägar och mobilitet:** En långsiktig kvalitetsutveckling av svensk forskning kräver ett fungerande och tydligt system för karriärvägar inom universitet och högskolor. För att skapa incitament och resurser för detta bör finansiering i ökad omfattning riktas mot meriteringsanställningar där forsknings- och undervisningsmeriter samt mobilitet beaktas.
9. **Jämställdhet:** Forskningens kvalitet stärks av ett jämställt forskningssystem. För att uppnå detta behöver lärosätenas ansvar för att främja jämställdhet utvecklas och redovisas genom uppföljningar av exempelvis hur basanslagen fördelas med avseende på kön.

10. **Etik, god forskningssed och oredlighet i forskningen:** Etik i forskningen är en grundpelare för forskningens genomförande, kvalitet och förtroende. Etiska prövningar av forskning behöver fungera på ett tillfredställande och likartat sätt inom hela det vetenskapliga fältet, och vid internationella samarbeten. Det bör upprättas en nationell uppförandekod för god forskningssed, och medvetenheten och kunskapen om forskningsetiska frågor behöver stärkas.
11. **Öppen tillgång:** För att göra det möjligt att ställa om till öppen tillgång krävs dialog mellan forskningssystemets aktörer, såväl nationellt som internationellt. Övergången till öppen tillgång till vetenskapliga publikationer måste ske med fokus på kvalitet i publikationer och med hänsyn till forskares meritering. För att lyckas med övergången till öppen tillgång till forskningsdata krävs en nationell strategi och ökade resurser.
12. **Forskningskommunikation:** Behovet av vetenskapligt grundad kunskap och förståelse för den vetenskapliga processen ökar. Arbetet med forskningskommunikation bör stärkas och samordnas så att forskare, lärosäten och forskningsfinansiärer kan komplettera varandra. Dessutom bör nya infrastrukturer för kunskapsförmedling som underlättar för forskare att kommunicera sin forskning utvecklas.

Summary: Future choices

Swedish research policy has long had the overall goal of making Sweden one of the world's foremost research and innovation countries, and a leading knowledge nation. The starting point is that high-quality research, higher education and innovation contribute in a fundamental way to societal development and welfare, a competitive business sector, and also address the societal challenges we are facing, both in Sweden and globally.

For many years, Sweden has also been investing heavily in research and development, with considerable R&D expenditure in relation to GDP. Furthermore, in international comparison Sweden is a country with a high percentage of researchers in the population, a high percentage of scientific publications per inhabitant and a population that has great trust in research. Despite this, Sweden has lost ground in a relative sense when it comes to research quality, as measured by citation impact. Sweden is thereby facing a number of challenges.

The Swedish Research Council has chosen to summarise these challenges in three overarching guidewords, to indicate the future choices for Swedish research strategy: *Knowledge, quality and integrity*. Research is and shall be the starting point for the knowledge and knowledge accumulation that shall form the foundation for societal development and welfare, business competitiveness and solutions to the societal challenges we are facing. But in order to reach the research policy goals, we must make sure that all research is of high quality and that excellence is prioritised. Here, the integrity and freedom of individual researchers are basic prerequisites, both for strengthening the quality of Swedish research and for new knowledge breakthroughs. Fundamental agreement on good research practice and increased transparency are crucial for maintaining and strengthening society's high level of trust in research and researchers.

To consolidate Sweden's role as a leading knowledge nation and become one of the world's absolutely foremost research and innovation countries, we do not just need to continue investing in research and knowledge accumulation. We also need measures focused on improving the quality of the research conducted at Sweden's higher education institutions. At the same time, we must safeguard both researcher integrity and trust in research.

Based on these guidewords for Swedish research, the Swedish Research Council has identified twelve items that are particularly urgent for achieving a Swedish research system of world class:

1. **Researcher-initiated research and undirected researchers:** Undirected researchers and undirected curiosity-driven research form the foundation for new knowledge, innovation and societal development. To create prerequisites for society's long-term development, support for undirected research must be strengthened and allocated on the basis of research quality, peer-reviewed in national or international competition.

2. **External funding and direct government funding:** External funding awarded in competition is needed to drive the development of Swedish research quality. The main goal of direct government funding via the appropriation to higher education institutions shall be to provide the best researchers with better, more long-term and stable conditions. The interplay between direct government funding and external funding by government agencies assumes a clear division of roles and a clear picture of how the different types of funding are used.
3. **Research infrastructure:** Advanced research infrastructure is often a prerequisite for carrying out research of the highest quality. To improve access to research infrastructure, the Swedish Research Council should receive increased resources to maintain and strengthen its role as responsible for prioritising, coordinating and funding research infrastructure.
4. **Prominent research environments:** Strong and creative research environments are an important factor for conducting research of high quality and for linking together research, education and society as a whole. Primary responsibility for building up research environments rests with the higher education institutions, at the same time as external funding forms an important complement. The higher education institutions should collaborate to a greater extent to create the best prerequisites for strong research and education environments.
5. **Strategic research initiatives:** Strategic research initiatives constitute an important complement to undirected, curiosity-based research. The Government should mandate the Swedish Research Council to establish a new council for strategic research, tasked with proposing areas for strategic research initiatives.
6. **Evaluation and quality assurance:** Evaluation of the results of research drives quality. In order for Swedish research to achieve the highest scientific quality, all research must be peer-reviewed. Evaluations conducted by higher education institutions and national actors should be implemented in such a way that they complement each other.
7. **Internationalisation:** Participation in international collaborations and contexts is crucial for the quality and development of Swedish research. Sweden should develop unified national strategies for internationalisation, covering both education and research.
8. **Career paths and mobility:** A functioning and clear career path system within the higher education sector is needed in order to develop the quality of Swedish research in the long term. To create incentives and resources for this, we propose that funding is increasingly aimed at the employment category “career development employment”, where research and teaching merits, as well as researcher mobility, are taken into account.

9. **Gender equality:** Research quality is strengthened by a gender-equal research system. To achieve this, the responsibility of higher education institutions to promote gender equality must be developed and reported through monitoring, for example of how direct government funding is allocated in terms of gender.
10. **Ethics, good research practice and scientific misconduct:** Ethics in research is a cornerstone for the execution and quality of research and trust in research. Research ethics reviews must work in a satisfactory and uniform way across the entire scientific field, including within international collaboration. A national code of conduct for good research practice should be established, and awareness and knowledge about research ethics issues need to be strengthened.
11. **Open access:** To enable the transition to open access, we need a dialogue between the actors in the research system, both nationally and internationally. The transition to open access to scientific publications must be made with focus on quality in publications, and with consideration for researchers' merit acquisition. In order to successfully transition to open access to research data, Sweden needs a national strategy, and to allocate resources to implement it.
12. **Science communication:** The need for scientifically based knowledge and understanding of the scientific process is increasing. Science communication efforts should be strengthened and coordinated, so that researchers, higher education institutions and research funding bodies can complement each other. New infrastructures for knowledge dissemination should also be developed, to make it easier for researchers to communicate their research.

Introduction

Knowledge, quality and integrity – guiding principles for Swedish research

Research is a cornerstone of the *knowledge* and knowledge accumulation that forms the basis for the development of a sustainable society. Research plays a central role in ensuring that we reach the global goals for sustainable development formulated in Agenda 2030.¹ The Swedish Government has stated that Sweden shall be a leader in the implementation of Agenda 2030, which does of course impact on the national research agenda.

Research and development are defined as “creative and systematic work aimed at increasing the amount of knowledge and finding new applications of existing knowledge within all fields of science”.² Research therefore contributes to increasing the general level of knowledge in society, it provides a background and history, and provides perspectives and reference points, as well as tools for looking forward. Research also contributes to the quality of education and to creating strong professions. In this way, knowledge and research form the foundation of our society, for safeguarding good economic development, our future welfare and sustainable welfare.

We are, however, living at a time when the importance of knowledge and research is being increasingly questioned – the existence of ‘alternative facts’ is a recurring theme in societal debate – and where access to knowledge and information is being individualised. This, in turn, has an impact on society’s trust in knowledge and science.³ To increase awareness of the role of research, and the role it may have in the future, it is important that research is done in open collaboration with society at large and to a greater extent than occurs today.

To address this and to create a solid knowledge basis for societal development, the research conducted must be characterised by high *quality*. This means that the resources invested in Swedish research must be allocated in a way that creates prerequisites for research of high quality. This includes providing long-term conditions to conduct research, enabling researchers to test their research ideas in national and international competition, and for the evaluation of research to be a natural part of the research system.

One of the most important prerequisites for research is the independence of the researcher to freely decide on the research question, method and result. This independence is important for the renewal of research, as it is undirected, curiosity-based research that often leads to ground-breaking discoveries. Such discoveries can

¹ United Nations. About the Sustainable Development Goals. 2019.

<https://www.un.org/sustainabledevelopment/sustainable-development-goals/> (Downloaded 2019-04-23)

² SCB (2018). Statistikens framställning – Forskning och utveckling i Sverige. 2018-10-12.; OECD (2015). Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris.

³ See, for example, ALLEA (2019). Trust in Science and Changing Landscapes of Communication. ALLEA discussion paper #3. January 2019.

usually not be foreseen, and are therefore not easy to bring about using strategic plans either. In order to not close the door on unexpected discoveries, it is therefore important for Swedish research to safeguard research *integrity*.

Research integrity is also dependent on research ethics considerations and guidelines. Ethics in research is a cornerstone for research quality, for society's trust in research and for the impact of research in society. Developments in recent years have shown that there is an increased need for awareness and knowledge of research ethics issues and reviews, both within academia and in society as a whole.

The scope and challenges of Swedish research

In an international perspective, Sweden has been investing major resources in research and development (R&D) for several years. In 2017, the overall expenditure on R&D in Sweden corresponded to 3.3 per cent of GDP. This means that Sweden exceeds the EU's goal of 3 per cent, and that Sweden is one of the OECD countries with the highest expenditure on R&D in relation to GDP (see Figure 1).

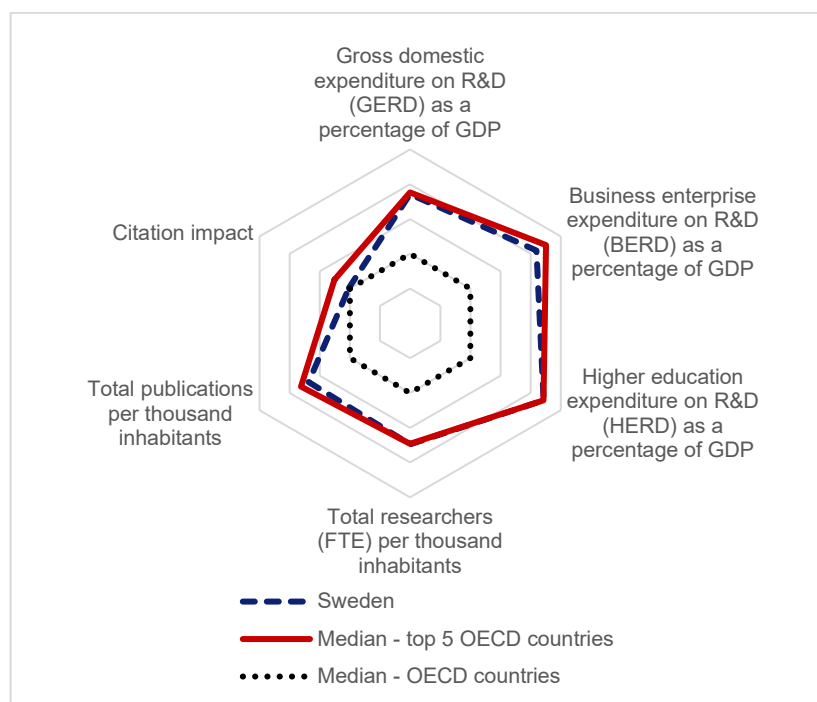


Figure 1. Swedish R&D in international comparison using a selection of indicators 2017

Note: Sweden's position is shown in relation to the median value for all OECD countries and the median value for the top five OECD countries.⁴ Data from 2017 or latest available year.

⁴ Top countries: Gross domestic expenditure on R&D as a percentage of GDP (South Korea, Israel, Switzerland, Sweden and Japan); Business expenditure on R&D as a percentage of GDP (Israel, South Korea, Japan, Switzerland and Sweden); Higher education expenditure on R&D as a percentage of GDP (Denmark, Switzerland, Sweden, Norway and Austria); Percentage of researchers (full time equivalents) per thousand inhabitants (Denmark, Sweden, South Korea, Finland and Iceland); Number of publications per thousand inhabitants (Switzerland, Denmark, Australia, Sweden and Iceland); Citation impact (Switzerland, United Kingdom, USA, Netherlands and Luxembourg).

The number of researchers refers to full-time equivalents. The citation impact refers to the 10 per cent most highly cited publications. Citation impact and publication refers to articles published 2015–2017. Sweden's citation impact is compared to the citation impact for the top five OECD countries and all OECD countries.

Source: OECD MSTI and Clarivate Analytics.

Government funding of R&D, either directly to the higher education institutions or to the government research funding bodies, are crucial for funding research where the market incentives for funding are lacking or are weak. Private and public research foundations also play an important role in funding research conducted within the higher education sector. A major part of Swedish R&D is funded and conducted by the business sector. This research is mostly focused on development and more applied research. The various parts of the research system therefore interacts, as basic research contributes to applied research, and vice versa. Interaction also occurs through funding of joint projects, and by persons moving between employments in different sectors.

Sweden is a country with a high percentage of researchers in the population. Together with the other Nordic countries, Sweden is one of the top countries, with around 0.75 per cent of the population working with research (see Figure 1). This can be compared with countries such as Netherlands, Switzerland, United Kingdom and Germany, where the corresponding percentage is between 0.4 and 0.5 per cent. Sweden is also among the top countries in terms of the percentage of scientific publications per inhabitant. Around 1.6 scientific articles per thousand inhabitants were published in Sweden in 2015–2017. This ranks Sweden after Denmark and Switzerland, but ahead of Netherlands, United Kingdom, USA and Germany. Sweden is also characterised by a population that has great trust in the importance of knowledge and research, which is an important prerequisite for the ability of science to solve societal challenges.⁵

The prerequisites for Sweden to be an internationally leading research nation are thus good. Despite this, Sweden is not among the foremost countries when it comes to the percentage of highly cited scientific publications (see Figure 1). In general, there is a positive correlation between countries' expenditure on R&D and their citation impact. This correlation exists, irrespective of whether we measure R&D expenditure in relation to GDP, or in relation to population size. However, the correlation is far from perfectly linear, which means that there are considerable differences between countries.

Differences in citation impact can therefore not be explained simply by countries' expenditure on R&D, but has more complex explanations. In addition to differences in expenditure on R&D, there are differences in the composition and function of the research systems, and therefore in the prerequisites for researchers to conduct research. In other words, an important challenge for the Swedish research system is how we can strengthen the conditions that will contribute to enhancing the quality of research.

The ambition to raise the quality of Swedish research also needs to take into account an international research landscape that is transforming. The number of Asian scientific articles more than doubled between 2007 and 2017, and Asia now

⁵ Vetenskap & Allmänhet (2018). VA-barometern 2018–19 – VA-rapport 2018:6.

produces more articles than North America or Europe. This implies that the competitive context has changed, at the same time as it also suggests new opportunities for research collaborations.

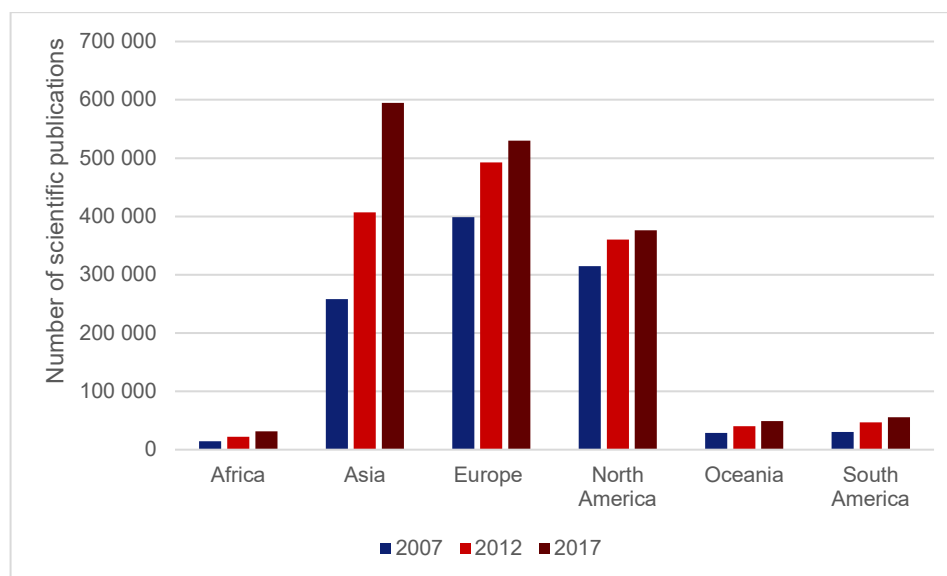


Figure 2. Number of scientific publications per continent and year.

Source: Clarivate Analytics.

The way forward

Research is and shall be the starting point for the *knowledge* and knowledge accumulation that form the foundation for societal development and welfare, for business competitiveness and for addressing the societal challenges we are facing. But in order to reach the research policy goals, all research must be of high *quality*, and this means that excellence must be prioritised. The *integrity*, independence and freedom of individual researchers are basic prerequisites both for increasing the quality of Swedish research and for new knowledge breakthroughs. Fundamental agreement on good research practice and increased transparency are at the same time crucial for maintaining society's great trust in research and in researchers.

The following chapters develop and describe the Swedish Research Councils' standpoints within twelve areas necessary for Sweden to achieve the goal of becoming one of the world's leading research nations.

1. Researcher-initiated research and undirected researchers

- Undirected researchers and undirected curiosity-driven research form the foundation for new knowledge, innovation and societal development.
- To solve the challenges of the future, researchers conducting basic research need better prerequisites.
- The funding of research must be based on the quality of research, which is assessed through peer-review in national or international competition.
- To create the necessary prerequisites for society's long-term development, support for undirected research must be strengthened.

Challenge: Guaranteeing undirected research and undirected researchers for knowledge and quality

Researcher-initiated basic research in all subject areas plays an invaluable role as the foundation for the knowledge accumulation that is necessary in order to solve today's major societal challenges, such as climate impact, an ageing population, and antibiotics resistance. Such research is also necessary to solve future challenges that we are not yet aware of. One of the most important tasks of the research system is therefore to make sure that both the space and the conditions for basic research and other undirected research are guaranteed and strengthened.

Much research consists of long-term systematic work that includes trial and error, routine work and collaboration. But research is also a creative activity with sudden insights, breakthroughs and unforeseen leaps. Searching for new knowledge is about conducting basic, theoretically solid and methodologically rigorous scientific analyses. These are a prerequisite for the other tasks of research: testing established truths, and solving practical problems. Undirected research increases the quality of higher education and provides society and business with a highly educated labour force. In this way, research creates a foundation for society's receptiveness to knowledge. It provides the knowledge basis that is necessary for placing new research findings or discoveries, wherever in the world they are produced, into a Swedish context, or for further developing them.

Based on the analysis of research content, it can be established that researchers who have the opportunity to freely formulate questions and problem areas to a large extent identify relevant social issues themselves, before these become the subject of special initiatives. A review of the research supported by the Swedish Research Council within humanities and social sciences shows that the applications for funds for research relating to relevant social issues measure up well in the very strong competition that applies for undirected project grants.⁶ Another review shows that climate-related basic research has received more than 1 billion SEK in support from the Swedish Research Council just in the last three years, without any special

⁶ Vetenskapsrådet (2019). Forskningsöversikt Humaniora och samhällsvetenskap 2019.

initiative.⁷ By relying on the researchers' own ideas, the Swedish Research Council can support research at an early stage of the development that leads to a challenge being identified, before the needs for new challenge-driven knowledge are recognised in the way that we are seeing today in areas such as antibiotics resistance and climate change.

Support for curiosity-driven research also has other purposes than those mentioned above. History shows that research breakthroughs that do not have any clear practical use when they occur can later on lead to solutions to societal problems, in forms such as medical applications and technical innovations. For this reason, research funding must be allocated with great freedom and width of scope, with the greatest possible emphasis placed on scientific quality.

The role of the Swedish Research Council: To safeguard researcher-initiated research

The Swedish Research Council funds basic research of the highest scientific quality in all fields of science. By far the greatest proportion of the support for research, around 80 per cent (not including research infrastructure support) goes to thematically undirected research, where the researchers themselves formulate the research problem. What characterises the Swedish Research Council's selection is the scientific quality of the research. The researchers awarded grants from the Swedish Research Council are chosen in national competition, following thorough peer review. This guarantees that it is the best research, with the greatest potential for contributing to knowledge development, which receives support.

The Swedish Research Council's research funding contributes to raising the quality of Swedish research, which in turn contributes to addressing societal challenges and makes it possible for Sweden to compete at international level. As the sole funding body in Sweden with this mandate, the Swedish Research Council thus plays a central role in safeguarding undirected research, in identifying the best research and in working to ensure those who conduct high-quality research get the prerequisites to develop their own ideas.

In the 2015 report on future choices for Swedish research, the Swedish Research Council recommended an increase in the funds for undirected project grants, and received a slight increase in the funds for humanities and social sciences in the subsequent Government bill.⁸ The Swedish Research Council has chosen to reallocate funds released from targeted initiatives to project grants in particular. This is because investing in researcher-initiated research in the form of thematically undirected project grants produces the best quality, and in the long term strengthens Sweden as a research nation.

⁷ Vetenskapsrådet (2019). Forskningsöversikt Naturvetenskap och teknikvetenskap 2019.

⁸ Vetenskapsrådet (2015). Forskningens framtid! Vägval för framtidens forskningssystem. Mål och rekommendationer.

The way forward

Freedom and quality: Researcher freedom, which is protected in the Swedish constitution, means that researchers are free to choose their research problems, methods, and how the results are to be published. This freedom is based on the autonomy and quality responsibility of the higher education institutions; they are free to choose the overall direction of research, who to employ, and how to allocate their own funds.

The Swedish Research Council considers that the freedom and autonomy of researchers, and simultaneously the quality of research, is promoted and strengthened via the mandate of the Swedish Research Council: to give researchers the opportunity to have their research ideas tried against stringent quality requirements in national competition, and – if the quality is sufficiently high – to have their research funded. In other words, external undirected research funding is very important both for the quality of the research and for the freedom and autonomy of researchers and research.⁹ In order for external funding to be given its proper scope, it is crucial that the best researchers are given the trust and the opportunity to work in an environment characterised by creativity and a long-term approach, and that they can set aside time for research and have access to relevant equipment or infrastructure in their employment. The ability of higher education institutions to give researchers these conditions and guarantee the freedom of research is therefore a basic prerequisite for safeguarding the quality of research.

Resources for undirected research: The Swedish Research Council considers it necessary to increase the funding of researcher-initiated research. For the Swedish Research Council, this relates in particular to undirected project grants, which raise the level of knowledge and are the fastest and most flexible way of addressing the challenges of today and tomorrow, and thereby contribute to aims such as the UN's sustainable development goals within Agenda 2030.

Every year, the Swedish Research Council receives a large number of very high quality applications that cannot be funded. An increase in the funds for undirected research would also allow increased room for support to researcher-initiated multidisciplinary projects, where we know there is great potential for research breakthroughs.

⁹ Sven Stafström: Externa medel behövs för frihet och kvalitet. Tidningen Curie, 2018-10-09
<https://www.tidningencurie.se/debatt/externa-medel-behovs-for-frihet-och-kvalitet/>

2. External funding and direct government funding

- Research funding applied for and awarded in broad competition is needed to drive the development of Swedish research quality within all subject areas.
- The main aim of direct government funding is to give the best researchers better, more long-term and stable conditions, and to provide the prerequisites for strategic recruitment.
- Interaction between direct government funding and external government funding assumes a clear division of roles, and a clear picture of how the different funds are used.

Challenge: How can the multiplicity of funding streams be utilised?

The Swedish research system has developed over a long period, and is characterised by a multiplicity of funding streams. A first division of funding can be made into direct government funding, external governmental funding bodies and other external funding bodies. Within each group of external funding bodies, there are a number of actors with complementary, but sometimes also overlapping, tasks or focuses. The tasks of the external governmental funding bodies vary, from the Swedish Research Council's broad and undirected funding, via Formas' and Forte's more targeted funding, to the clearly delimited funding from various government agencies. In the discussion about external and direct government funding, it is also important to consider that different funding bodies contribute to differing degrees to the indirect costs of the higher education institutions.

Government funding for research and third cycle higher education today represents 70 per cent of the higher education institutions' funding, and is allocated both via direct government funding (44 per cent) and via external funding bodies, such as research councils and government agencies (26 per cent). Private external funding via companies and non-profit organisations represents almost 16 per cent. Funding from municipalities and county councils and public research foundations, and from EU and other foreign funding, cover 7 per cent each. The many funding sources can be seen as an expression of great trust in the ability of research and Swedish higher education to contribute to solutions to societal challenges.

In the Swedish research system, research institutes represent a relatively small part of all research. The expectations on higher education institutions to produce the knowledge society needs are therefore set at a high level. At the same time, all higher education institutions have the same mandate to provide research, education and collaboration, which differs from that of many other countries, where there is a clear distinction between research-focused universities on the one hand, and education-focused university colleges on the other hand.

In a recently published report from the Swedish Research Council, focusing on research-oriented departments, it is established that the direct government funding

for research primarily funds professors, senior lecturers, associate senior lecturers and, in some areas, also doctoral students and postdocs. Researcher employment and the vast majority of doctoral students and postdocs are primarily financed using external funds.¹⁰ The Swedish Research Council's research overviews show that in some areas, external funds are also used to fund research time for senior lecturers and professors.¹¹ These are primarily operations with a very large percentage of external funding, and areas with large first cycle higher education mandates. The Swedish Research Council's considers that in normal cases, permanently employed teachers should be funded by direct government funding, and that external funding should be used to fund temporary employment and project-related costs.

It is important to underline that the work of teaching employees should normally cover both teaching and research, and that the employment should be funded by both these types of appropriation. There must however be some flexibility built into the proportion of both these mandates, both between individuals and over time.

A major challenge concerns how indirect costs are to be funded. As a result of the high proportion of external funding, a model was introduced that fully covered indirect costs, so that all funding bodies contribute to the joint costs of higher education institutions. The governmental research funding bodies have a duty to provide full cost coverage of indirect costs. For the Swedish Research Council's support for research, excluding research infrastructure, this means that around 24 per cent, or just over 1 billion SEK per year, is provided for indirect costs. For various reasons, external funding bodies other than the governmental ones do not contribute to these costs to the same extent. As in many cases a researcher's or research team's activities are financed with funds from several different sources, the institution managers and research leaders have to find ways to make the funding from different sources cover the indirect costs that arise in conjunction with the research. Today's application of the model for full cost coverage means that external governmental research funding bodies contribute to the higher education institutions' internal costs to a larger extent than many other external funding bodies. The application of this rule means that the governmental funding bodies' contributions can often even be seen as a prerequisite for accepting funding from the other external funding bodies. In practice, this can lead to a support function that differs from the expressed one, namely to support excellent research. Overall, this contributes to a lack of clarity between the roles of different actors, which needs addressing.

The role of the Swedish Research Council: To be a quality-driving external research funding body

As the largest external source of funding of research, the Swedish Research Council plays a crucial role in the Swedish research system in guaranteeing the scientific quality of research, in terms of both funding and continuity, and also quality evaluation. The undirected research grants renew research, and, through the curiosity

¹⁰ Vetenskapsrådet (2019). Externfinansieringens roll i svensk högskoleforskning. En fallstudie av några forskningsorienterade institutioner.

¹¹ See for example Vetenskapsrådet (2019). Research overview 2019, Natural and engineering sciences.

of researchers, societal challenges are discovered or addressed in many cases before they have had an impact in a broader societal discussion.

In the Swedish Research Council's study of research-oriented departments in academia, all state that project support from the Swedish Research Council is of particular importance, due to its prestige, volume and freedom in use. The importance in terms of quality assurance of research is also emphasised.¹²

Funding from the Swedish Research Council drives quality because of the national competition, in which peer review forms the basis for awarding grants to applications. National benchmarking is a better way of ensuring quality than competing for direct government appropriation funds at an individual higher education institution. Similar arguments are used for the ERC grants, which are based on competition at European level. Applying for and being awarded external research grants is seen by the departments included in the report as one of the most important forms of quality control and quality assurance.¹³

Funding from the Swedish Research Council is also of great importance for the chances of receiving further external funding, from bodies such as the ERC and the Wallenberg Foundations.

The way forward

Demands for an increased percentage of direct government funding has long been made by the higher education institutions.¹⁴ The high level of external funding is considered to be an obstacle to the higher education institutions' ability to act strategically, and for creating long-term sustainable prerequisites for researchers to develop their activities. At the same time, funds from the Swedish Research Council are perceived as being the least directed, and can therefore not be said to have a competing strategic focus.

In a report on the Swedish innovation system from 2016, the OECD writes that it is not primarily increased basic resources that lead to increased performance.¹⁵ In the research system, there is a striving for growth that is based both on the willingness of researchers to realise their ideas, and on an institutional striving to show success and to compete for direct funding and external funding.

A sustainable development, with or without an increased percentage of direct government funding, must be to limit the number of researchers and instead give each researcher better prerequisites for conducting high-quality research. More junior researchers must be given the opportunity to achieve the more attractive career development employment format, and the researcher employment format should be used to a considerably smaller extent than is currently the case. How such a development can be stimulated is discussed in greater detail in Chapter 8.

In the cited study of research-oriented departments, it was established that the economic scope is too limited to create prerequisites for strategic recruitment to

¹² Vetenskapsrådet (2019). Externfinansieringens roll i svensk högskoleforskning. En fallstudie av några forskningsorienterade institutioner.

¹³ Ibid.

¹⁴ See for example several of the inputs to the Government's research bill, Prop. 2016/17:50 Kunskap i samverkan – för samhällets utmaningar och stärkt konkurrenskraft.

¹⁵ OECD (2016). OECD Reviews of Innovation Policy: Sweden 2016. OECD Publishing, Paris.

enable the build-up of a long-term sustainable organisation. This is an important part of the type of costs the direct government appropriation must cover. Together with clearer responsibility for costs for permanently employed personnel, as discussed above, costs of local research infrastructure and part of national research infrastructure (see Chapter 3), the Swedish Research Council considers that this justifies an increase of the direct government appropriation.

A partly changed view of how the direct government appropriation is used could have many positive effects on research quality. The aim of the change is that it must lead to long-term and more stable conditions for individual researchers, at the same time as a quality-driving force is more clearly built into the activities of the higher education institutions. Here there is room for the higher education institutions to think more strategically, and with a more long-term view also in terms of external funding.

There are gaps in the follow-up of how direct government funding is used, and what effect it has on researchers' conditions. Examples of these are how the direct government funding impacts on gender equality and recruitment processes, or secures good conditions for individual researchers. Documentation for following up the use and allocation of the direct government funding at a more detailed level than is currently available is needed to enable analysis of how this impacts on the quality of Swedish research. For example, there is a need for documentation of how the direct government funding is allocated to women and men, different employment forms and different types of cost.

With the focus on the use of the direct government funding described above, the funding instrument of the Swedish Research Council may have to change. As described in Chapter 1, undirected project grants should be given an increased budget and have a clearer focus on temporary, project-related costs, and thereby complement the direct government funding's use to finance permanent employment and other more long-term undertakings. Undirected project grants have the great advantage of not becoming controlling of higher education institutions' prioritisations. On the contrary! Successful higher education institution prioritisation is reinforced through competitive research initiatives being given supplementary support. However, some national prioritisation in the form of targeted initiatives should still be made. The Swedish Research Council's views on how such prioritisations should be made are presented in Chapter 5.

3. Research infrastructure

- Advanced research infrastructure is often a prerequisite for carrying out research of the highest quality.
- Swedish investment in research infrastructure needs to increase and be coordinated with research initiatives, to address societal challenges and safeguard the competitiveness of Swedish research.
- The Swedish Research Council should receive increased resources to maintain and strengthen its role as responsible for prioritising, coordinating and funding research infrastructure in the Swedish research system, and to cover the cost of participating in international infrastructure.
- The formats for organisation and management of major national research infrastructures should be reviewed, to improve and increase the efficiency of access to infrastructure, and to facilitate coordination.

Challenge: Access to research infrastructure must be safeguarded

To maintain and strengthen Sweden's position as a prominent research nation, and thereby safeguarding the competitiveness of our research and industry, researchers active in Sweden need to be given the best opportunities to conduct prominent research. This, in turn, requires access to advanced research infrastructure.

The need for research infrastructure – large research facilities, laboratory environments, experimental workshops, digital research systems and comprehensive databases and registers – is growing rapidly within most research fields. Advanced research infrastructure also constitutes a resource for industry, and is in many cases a prerequisite for collaboration between industry and academia. The need to study changes and their causes is becoming ever more important, and is dependent on observations that cover long time periods. At the same time, complex questions require increased collaboration, and data from several sources that can be combined. This, in combination with rapid technical development within research and research infrastructure, also places increased demands on open research data and application of the 'FAIR principles', which state that data shall be *Findable, Accessible, Interoperable, Reusable*.¹⁶ These demands have repercussions, in the form of further needs for e-infrastructure for storage, transfer, and analysis, and also for long-term planning, increased personnel resources and specialist competence. Implementation of the FAIR principles is dependent on increased resources for both basic technical infrastructure and advanced e-infrastructure for research (see also Chapter 11 on open access).

Research and its infrastructure generate and use ever growing amounts of data, which leads to a rapidly increasing need for e-infrastructure for computing, analysis,

¹⁶ Wilkinson, M. D. et al. (2016-03-15). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data* 3, DOI 10.1038/sdata.2016.18.

transfer and storage of data. This development means that researchers without previous experience of digital research infrastructure will need to use digital services and e-infrastructure. This places increased demands on support and competence development within several areas.

Investment in research infrastructure is always of strategic importance. It is directed in the first instance by the needs of research, but at the same time, advanced infrastructure creates prerequisites for the development of research. For this reason, investment in research and infrastructure should be coordinated. In many cases, research infrastructure generates unique research environments with the potential of attracting the best researchers in the world – environments where new insights and research breakthroughs are obtained, and new national and international collaborations are established (see also Chapter 4 on prominent research environments). Furthermore, environments like these can contribute to growth in the country or region where the research infrastructure is located – through deliveries, innovations and secondary effects that follow from visiting researchers and their families.

It is necessary to encourage and support researchers, higher education institutions and industry to contribute actively to instrument and technology development. In addition to support for mobility, establishment and development of companies, we also need incentives for highly qualified persons and their relatives who are considering relocating to Sweden, or who are already here, to choose to remain and work in the country. To facilitate this, policies, laws and regulations need to be reviewed.

Stimulating researchers to engage in the development and operation is necessary in order to build up, operate and develop advanced research infrastructure. Those who work at the infrastructure must be offered good working conditions, competence development and career opportunities. Merits from building up and operating research infrastructure must be upgraded and recognised when appointing personnel. A coordinated discussion about researchers' career paths and earning of merit needs to be held at Swedish higher education institutions and research funding bodies.

In order for the necessary investment made at research infrastructure of national interest to benefit society even more, a number of measures are necessary. As infrastructure is becoming ever more advanced and expensive, the importance of national coordination and prioritisation increases. Here, the Swedish Research Council plays a central role, and has great responsibility. At the same time, the formats for organisation and management of national research infrastructure need to be reviewed.

The role of the Swedish Research Council: Overall responsibility for prioritisation and funding of research infrastructure of national interest

Currently, the Swedish research system has divided responsibility for research infrastructure. Higher education institutions are responsible for ensuring their researchers have access to the resources they need in the form of local equipment or

infrastructure. For research infrastructure of national interest, which also includes participation in international infrastructure, it would drive quality and be cost-effective for the Swedish Research Council to continue having primary responsibility for prioritisation, coordination and funding.

Systematic collaboration on research infrastructure has already been established between the Swedish Research Council and Sweden's higher education institutions, but the Swedish Research Council would like to further strengthen the collaboration between and within funding bodies, infrastructures, higher education institutions, regions and other actors. The regions are particularly important for the collaboration Clinical Studies Sweden¹⁷, for improved prerequisites for clinical research¹⁸ and for the mandate to promote register-based research¹⁹, where metadata from quality registers are made available via the infrastructure RUT (Register Utiliser Tool). The Swedish Research Council and the Universities' Reference Group for Research Infrastructure (URFI) have jointly commissioned an international expert panel to review the national e-infrastructure landscape, with its various national and international actors. The panel presented eleven recommendations for how Sweden could develop a national strategy for e-infrastructure for research.²⁰ The Swedish Research Council is now continuing this work in collaboration with the higher education institutions in order to address the increased demands for effective organisation of our future e-infrastructure.

Since the previous edition of this report, the Swedish Research Council has implemented a new model for funding research infrastructure. This entails, among other things, a clearer strategic prioritisation and strengthened and long-term collaboration with Sweden's higher education institutions and other research funding bodies on issues relating to research infrastructure. Forte, Formas and Vinnova are already taking part in the Swedish Research Council's strategic work on research infrastructure. The Swedish Research Council is also stimulating Swedish participation, use and competence supply to the European Spallation Source (ESS) and has been given further responsibility to support the government in hosting ESS.

In *The Swedish Research Council's Guide to Infrastructure 2018*, which was produced in collaboration with a number of actors, there are ten overarching and a number of more detailed strategic prioritisations and recommendations for measures within the research infrastructure area that are needed to strengthen the Swedish research system.²¹ A large part of this chapter is based on the wording in the Guide.

The way forward

Investment, prioritisation and direction: To meet the increasing needs of research for advanced research infrastructure and to enable renewal, greatly increased investment is required. At the same time, clearer prioritisation, better coordination, increased collaboration and more effective use of Swedish research infrastructure is

¹⁷ The Swedish Research Council's website for the Clinical Studies Sweden collaboration: <https://www.kliniskastudier.se>

¹⁸ Vetenskapsrådet (2019). Forskningsöversikt Klinisk behandlingsforskning 2019.

¹⁹ The Swedish Research Council's website for register-based research: <https://www.registerforskning.se>

²⁰ Vetenskapsrådet (2019). An outlook for the national roadmap for e-infrastructures for research.

²¹ Vetenskapsrådet (2018). Vetenskapsrådets guide till infrastrukturen 2018.

needed. Participation in international initiatives is becoming ever more important to fulfil the needs of research for advanced research infrastructure. The work on improving the model for prioritising infrastructure investments will therefore continue. However, better prioritisation is not enough; to enable the Swedish Research Council to continue taking overall national responsibility for Swedish research infrastructure and Swedish participation in international infrastructure, increased financial resources are necessary. Increased costs of participating in advanced international infrastructure in combination with a weak Swedish krona makes it impossible for the Swedish Research Council to continue developing the national research infrastructure. Here, the Government needs to take responsibility for long-term funding.²²

At the same time, Sweden's higher education institutions need to ensure that investment is made in local equipment and infrastructure, including e-infrastructure. Such investments must be coordinated to avoid under-utilisation of expensive equipment and other resources. Considerable inputs are also needed, not least at our higher education institutions, to build up the competence that is required to ensure Swedish research can benefit from the opportunities offered by advanced research infrastructure and large data sets.

Max IV is the largest investment in national research infrastructure ever made in Sweden. The facility is now moving from the construction phase to operation, which means long-term funding of the facility needs to be ensured. At the same time, Sweden must fulfil the undertaking to host ESS in the best way possible, and prepare the Swedish research community for the facility becoming operational. It is of great importance for guaranteeing quality that funds continue to be invested, and that the usage is followed up.

Investments in infrastructure and investments in research and education must be coordinated to ensure the greatest possible impact. Major investment in research should take account of the needs for research infrastructure that the research will generate, and as applicable include funds to strengthen or develop the necessary infrastructure.

For the major national research infrastructures to be developed to their full potential, and thereby continue to strengthen Swedish research, the formats for organisation and management of these should be reviewed.

Increased need for e-infrastructure and data management: Investment in e-infrastructure must increase to address rapidly growing data volumes and the need for research to analyse ever increasing and more complex data amounts. Already in the 2015 edition of this report, the Swedish Research Council highlighted the need for increased investment in e-infrastructure. Since then, the format for supporting the large-scale computing resources within the framework for SNIC (Swedish National Infrastructure for Computing) has been adapted, however without enabling the Swedish Research Council to increase its funding of SNIC. National actors, such as the Swedish Research Council and Sweden's higher education institutions, now need to develop jointly a uniform organisation and funding model, including investments in user support and education, for national Swedish e-infrastructure. Sweden also needs to take active part in many of the international collaboration

²² Vetenskapsrådet (2019). Strategisk plan RFI 2020-2023 (published in autumn 2019)

schemes that are now in progress and planned. In order for Sweden to benefit from its engagement in the EuroHPC initiative, which is both investing in a European high-performance computing system and supporting research and innovation in the area, clear responsibility is required, coupled with matching resources.

Safeguarding of personal integrity is central for the credibility and legitimacy of research. Swedish legislation therefore needs to be developed and designed in such a way that research can use existing data in an optimal way, and that systematic build-up of research data is enabled while maintaining personal integrity. New technical solutions for co-analysing sensitive data from different sources, including register-based data, biobank data and data collected within health and medical care are necessary. The register-based infrastructure RUT, which is operated and developed by the Swedish Research Council, is a unique resource for research and innovation, in particular within individual-based therapy, known as ‘precision medicine’. Sweden has great potential to be at the forefront in this area, and to attract the best researchers and more clinical studies to the country.²³ Swedish legislation and legal practice need to be adapted, for example to the European General Data Protection Regulation, based on knowledge about research and the needs of research.

²³ RUT is accessed via the Swedish Research Council’s website <https://www.registerforskning.se>.

4. Prominent research environments

- Sweden needs more strong and creative research environments that contribute to knowledge development and Swedish research of high quality.
- Primary responsibility for building up good research environments rests with the higher education institutions, but external funding via targeted environment support constitutes an important complement.
- To create the best prerequisites for strong research and education environments, the higher education institutions should collaborate to a greater extent and concentrate available resources to avoid fragmentation.

Challenge: How are the best research environments created?

A research environment is a unit that shares a research idea and a vision for its research, and that works according to clearly defined common goals. A research environment can be built up around research infrastructure, around thematic or multi-disciplinary questions, or around a small group of successful researchers, for example. Research environments can differ significantly in size; one or more higher education institutions can be involved, and there are several ways of organising the environments. They do not have to have a joint physical location – there are many examples of successful distributed research environments. In addition to the shared research idea, a prominent research environment is characterised by good research leadership and a well-defined framework for how collaboration within and outside the environment shall be conducted. An analysis of what characterises prominent research environments in England shows that they are distinguished by features such as the research team's composition, research culture, leadership, collaborations and networks, strategies, funding and institutional support structure.²⁴

A prominent research environment entails a number of positive effects. Perhaps the most important one is that the environment is attractive to junior researchers, who can further develop the environment when those who started the environment are no longer active. A prominent research environment therefore usually lasts for longer than the career of an individual prominent researcher. It can address complex questions that require a multiplicity of competences, and can cover basic research and applied research as well as innovation. It can function as a platform for educating new generations of researchers, be an attractive meeting point for the best researchers, and develop over time. In this way, it facilitates the recruitment of prominent participants both nationally and internationally. A good research environment can contribute to first cycle higher education and knowledge provision within considerably broader areas than those the research is primarily aimed at. The combination of width and leading-edge competence among teachers at higher education institutions provide the very best prerequisites for high-quality education.

²⁴ According to the definition used for "high-performing research units", Kings College London (2015). Characteristics of high-performing research units: A preliminary analysis. Research Report 2015/02 The Policy Institute at King's College London and RAND Europe.

Higher education institutions are responsible for both teaching and research. To safeguard the quality of teaching, research needs to be conducted at every higher education institution, which is emphasised in various educational evaluations. This means that the resources for research within different subject areas, which often exist at a large number of higher education institutions, is distributed, which risks creating sub-critical environments.

The role of the Swedish Research Council: To support research environments

The Swedish Research Council offers three types of environment support: Research environment and research collaboration support, distinguished professor support and international recruitment support. The research environment and research collaboration support aims to create added value from collaboration between research teams or individuals. The applicant shall be a constellation of several researchers from different higher education institutions and/or subjects, nationally or internationally, who are working towards a common research goal in the long term. The calls are issued by individual scientific councils and committees at the Swedish Research Council, or jointly by several of them, and are evaluated in terms of the highest scientific quality. In 2019, calls are being issued for research environment grants within natural and engineering sciences, register-based research, and clinical therapy research. The distinguished professor and international recruitment grant forms make it possible for the very most successful researchers to build up long-term sustainable research environments focusing on pioneering research. The grant forms are aimed both at researchers at Swedish higher education institutions and at researchers from other countries, who are thereby recruited to Sweden.

The evaluation of initiatives to support what is known as ‘excellent research environments’ done in Sweden, such as the Linnaeus support and strategic research areas, clearly show the value of such environments. The initiatives have contributed to developing new research areas, to increased risk-taking in combination with high ambitions, to new approaches, to new collaborations in new constellations, to reinforced third cycle higher education and to increased opportunities to attract further external funds and recruit personnel.²⁵

In 2015, the Swedish Research Council conducted an overview of analyses of initiatives for excellent research environments in the Nordic countries. The overview shows that the scientific production usually increases, but that there is great variation in terms of to what degree it is possible to show an increase in the quality of research through bibliometric analysis. It should be noted that most of these environments were high-performing, and above the world average in terms of citation rate even before the initiatives were launched.²⁶

²⁵ Vetenskapsrådet (2012). Mid-term evaluation report of the 2006 Linnaeus environments and doctoral programmes; Vetenskapsrådet (2014). Mid-term evaluation report of the 2008 Linnaeus centres, Vetenskapsrådet (2015a). Analys och utvärdering av särskilda satsningar – underlag till Vetenskapsrådets inspel till 2016 års forskningsproposition; Vetenskapsrådet (2015b). Evaluation of the strategic research area initiative 2010-2014.

²⁶ Vetenskapsrådet (2015a). Analys och utvärdering av särskilda satsningar – underlag till Vetenskapsrådets inspel till 2016 års forskningsproposition.

The way forward

Counteract fragmentation: Several of the research overviews produced by the Swedish Research Council's scientific councils, councils and committees emphasise that support for research environments is in many cases a suitable way of reinforcing the quality of research and reducing fragmentation in interaction with higher education institutions.²⁷ As in the previous edition of this report, the Swedish Research Council wishes to emphasise that the main responsibility for building up and providing basic funding for research environments lies with the higher education institutions, as it relates to long-term strategic support closely linked to the employment of key persons in these environments.²⁸ Higher education institutions should collaborate to a higher degree and concentrate resources to create the best prerequisites for strong research and teaching environments.

Funding: External funding bodies should continue to co-fund prominent research environments, because of the added value to both research and education that the environments provide. The support should be long-term, with regular follow-up and evaluation. The Swedish Research Council intends to continue its grants for research environments and distinguished professors. As far as the former is concerned, this grant form is used for both thematic and undirected initiatives, while the distinguished professor grant is only used for undirected research. As always when it comes to external funding, the quality of the research is the focus when evaluating applications. When it comes to major research environment support, it is important to maintain a dialogue between the higher education institutions and external funding bodies in order to link together long-term external initiatives with higher education initiatives in the best possible way. Such a dialogue also opens the door to opportunities for integrating research and educational initiatives.

²⁷ Vetenskapsrådet (2019a). Forskningsöversikt Humaniora och samhällsvetenskap 2019.; Vetenskapsrådet (2019b). Forskningsöversikt Klinisk behandlingsforskning 2019.; Vetenskapsrådet (2019c). Forskningsöversikt Konstnärlig forskning 2019.; Vetenskapsrådet (2019d). Forskningsöversikt Utbildningsvetenskap 2019.; Vetenskapsrådet (2019e). Forskningsöversikt Utvecklingsforskning 2019.

²⁸ Vetenskapsrådet (2015c). Forskningens framtid! Vägval för framtidens forskningssystem. Mål och rekommendationer.

5. Strategic research initiatives

- Strategic research initiatives constitute an important complement to undirected, curiosity-based research.
- The Government should mandate the Swedish Research Council to establish a new council for strategic research, tasked with proposing areas for strategic research initiatives. The proposals should form the basis for the Government's prioritisation of strategic initiatives.

Challenge: How to identify areas for future initiatives?

Undirected researchers and undirected, curiosity-driven research constitute a foundation for knowledge, for innovation and for societal development. Undirected research is responsible for research breakthroughs, and forms the basis for new, expansive research areas. Undirected research is also closely linked to societal challenges, as researchers are part of society, and their curiosity is a driver for finding solutions to societal challenges. The Swedish Research Council has shown that undirected research has contributed to areas that can be categorised as challenge-driven. Examples of these are the global sustainability goals, where the Swedish Research Council's funding within the framework for undirected project grants has contributed to research linked to these goals.²⁹

Targeted initiatives in strategically important research areas form a necessary complement to undirected research, for example when it comes to developing Swedish areas of strength, and for capacity-building. When research breakthroughs occur, or when the need for solutions to societal challenges and business competitiveness becomes particularly apparent, research funding bodies need to set aside targeted funds to give such areas an opportunity to expand temporarily.

Strategic initiatives aimed at addressing societal challenges are often made, both nationally and internationally. Examples in Sweden are: *Strategic research areas* (Swe: "*Strategiska forskningsområden – SFO*"), which refer to initiatives for prominent research environments. Special research initiatives (Swe: "*Särskilda forskningsåtgärder*"), which refer to initiatives targeted at specific research subject areas or research infrastructures. The national research programmes (Swe: "*Nationella forskningsprogram*"), which are intended to address societal challenges. *Strategic innovation areas* (Swe: "*Strategiska innovationsområden – SIO*"), which refer to targeted initiatives to strengthen the innovation chain from research to implemented solutions.³⁰

Strategic initiatives are also prominent in international and European collaborations, for example within the pillar for societal challenges in Horizon 2020. Targeted initiatives will probably be even more prominent in the EU's upcoming framework programme Horizon Europe, where Agenda 2030 and "missions" will

²⁹ Vetenskapsrådet (2016). Avrapportering av regeringsuppdraget om att bidra med underlag för Sveriges genomförande av Agenda 2030. Dnr. 3.3-2016-6545.

³⁰ Prop. 2016/17:50. Kunskap i samverkan – för samhällets utmaningar och stärkt konkurrenskraft.

form a central part. It is important for Sweden to put forward the strategic initiatives we consider should be prioritised nationally and internationally. However, and contrary to what is the case in many other countries, Sweden lacks a scientifically based process for identifying such areas.

The role of the Swedish Research Council: To provide broad experience of strategic initiatives

The Swedish Research Council has long worked with challenge-driven research funding in areas such as the national research programmes within antibiotics resistance, and migration and integration, within Horizon 2020 and within the partnership programmes and joint programme planning, such as JPIAMR and JPND.³¹ The Swedish Research Council's funding of research infrastructure is also an example of initiatives in strategic areas, as researchers active in areas that can utilise new advanced infrastructure tend to seek out where the latest technology or the best opportunities exist.

The national research programmes were initiated by the Government in 2016, on the advice from the Swedish Research Council and the other governmental research funding bodies.³² They are instruments for building up coordinated, multidisciplinary, long-term and strategic initiatives. By mapping knowledge needs, actors and existing initiatives, the national programmes work strategically to determine which initiatives should be prioritised and implemented. The work on the focus of the national programmes is based on a strategic research agenda, and the work has involved a broad range of actors, such as researchers, research funding bodies, public agencies, civil society and representatives of the business sector.

The Swedish Research Council has considerable experience of working with targeted initiatives on societal challenges within Horizon 2020. The process for developing opinions on the programmes aims to take into account different perspectives, and to involve a broad range of actors, such as researchers, representatives of public agencies, and research funding bodies. An important starting point for this work is that the initiatives are targeted in terms of the problems and challenges to be addressed, while it is up to the researchers to determine how the problems should be solved. In this way, these targeted initiatives consist of a significant “bottom-up” component, both because the researchers participate in designing the focus of the calls, and also because it is up to the researchers to determine how the questions should be answered.

The way forward

Initiatives involving strategic research areas constitute a valuable complement to undirected, curiosity-driven research for developing Sweden's areas of strength, for

³¹ Vetenskapsrådet. Samarbete inom ERA och partnerskapsprogrammen. 2019. <https://www.vr.se/analysoch-uppdrag/vart-internationella-arbete/era-och-partnerskapsprogram.html> (downloaded 2019-04-23).

³² Energimyndigheten, Formas, Forte, Rymdstyrelsen, Vetenskapsrådet och Vinnova (2015). *Analys och förslag till regeringens forsknings- och innovationsproposition*.

addressing societal challenges, and for strengthening the competitiveness of the business sector.

Processes for identifying strategic research initiatives are of central importance, but do not have a clear structure in the current research system in Sweden. Such processes must be able to handle the research community's knowledge of the opportunities offered by science, but also the needs that arise from society and business. The Swedish Research Council therefore proposes that the Government should mandate the Swedish Research Council to establish a new *council for strategic research*, tasked with proposing areas for strategic research initiatives. The proposals should form the basis for the Government's prioritisation of strategic initiatives.

The council's composition should reflect the demands that exist for both excellent research within the areas prioritised, and for societal relevance and utilisation of the research. The Swedish Research Council also intends to develop the use of tools for knowledge support for the work of the council of identifying strategic research areas, such as automated text analysis and AI-related tools. A starting point for identifying strategic research areas should be that they shall be targeted only in terms of the challenges to be addressed, while it must be up to the researchers to propose how this can best be done.

6. Evaluation and quality assurance

- Evaluation of the results of research drives quality.
- In order for Swedish research to achieve the highest scientific quality, all research must be peer-reviewed.
- In many areas, there is a need to obtain a picture of the state of Swedish research through national and international comparisons.
- Evaluations conducted by higher education institutions of their own research, and the national evaluations of research conducted by bodies such as the Swedish Research Council complement each other and form a basis for developing the quality of Swedish research.

Challenge: The evaluation of Swedish research in a national and international perspective needs to be strengthened

Main responsibility for the quality of the activities conducted at Sweden's higher education institutions lies with the institutions themselves. Several of these regularly evaluate the quality of research using peer review.³³ The focus of the evaluations has varied over time. Initially, they were principally aimed at evaluating quality, but in several cases they have changed to have a clearer focus on quality development.³⁴ The higher education institutions' evaluations are thereby an important tool for developing research. They can identify weaknesses and strengths, and provide a basis for prioritisation of different research initiatives at higher education institutions.

Following the most recent Government research bill, the Swedish Higher Education Authority (UKÄ) was given an expanded mandate, which means that its audits of the higher education institutions' quality assurance shall now also cover how they safeguard quality in research. Development work is ongoing at UKÄ, with the aim of including this in the audit system as from 2021. The audits that UKÄ conducts do not concern quality in itself, but how the higher education institutions' own evaluations and other inputs are used to safeguard and develop quality. The Association of Swedish Higher Education Institutions (SUHF) has produced a framework for how the institutions should carry out quality assurance of research. This shall both form a foundation for SUHF's members and serve as a documentation basis for UKÄ's development work.³⁵

Many research funding bodies are also conducting evaluations of research within the areas they provide support for. In general, these evaluations are based on peer review with panels composed of international members. They are often limited to

³³ Some examples are: University of Gothenburg (GU:RED10 and RED19), University of Skövde (HS:ARC13), Karolinska Institutet (KI:ERA2010), KTH Royal Institute of Technology (KTH:RAE08 and RAE12), Södertörn University (SH:SER2015), Swedish University of Agricultural Sciences (SLU:KoN09), and Uppsala University (UU:KoF07, KoF11 and KoF17).

³⁴ See for example UU:KoF17 and GU: RED19.

³⁵ SUHF (2019). Gemensamt ramverk för lärosätenas kvalitetssäkring och kvalitetsutveckling av forskning, Dnr. 0009-19.

evaluating the projects that have received support, but in some cases the scope is wider and includes all research within the area. These evaluations provide a more-or-less comprehensive picture of research quality within the area in question. They also provide the funding bodies with important insights that can be used to develop their own support activities, and also opportunities to highlight more general challenges that politics can address.

Another central part of the quality assurance of Swedish research is provided by the peer review that occurs in conjunction with applications for research funding, in particular at external research funding bodies. Research plans are scrutinised for quality in national or international competition, with the aim of identifying the best projects with the greatest potential to contribute to new knowledge. This peer review enhances quality.

However, a system is lacking for evaluations with an overall scope that cover all the research within an area, from a disciplinary or thematic viewpoint, and that use national and international comparisons conducted by expert panels consisting of international members to provide a picture of research quality in Sweden within the area. The importance of research for societal development also needs to be a feature of evaluations to a greater extent, besides the scientific quality. Irrespective of the focus of the evaluations, it is only when the results of them are converted in action, primarily at higher education institutions, that the desired quality development becomes reality.

The role of the Swedish Research Council: To provide peer review and evaluation that drive quality

The Swedish Research Council's prioritisation of support for research is entirely based on peer review of applications. The review is conducted by independent researchers, often from other countries, with a high level of scientific expertise within the research area in question. The decisions are thereby based on assessments of scientific quality made by those best able to make them. Such peer review is an established method, with strong roots and general acceptance in the research community. For this purpose, the Swedish Research Council has developed eight general principles for peer review to guide the work and guarantee the quality of the review.³⁶

The Swedish Research Council also carries out evaluations of the results of research, both in terms of the quality of the research produced and in terms of the importance of the research to the surrounding society, as well as evaluations in response to specific Government mandates. These might relate to research within a certain area, as was the case for the evaluation of Swedish clinical research (ALF evaluation), or evaluations of research policy initiatives, such as the ongoing evaluation of the Linnaeus research environments.³⁷ The starting point for evaluations conducted as a result of the Swedish Research Council's directive is that Swedish research needs to be evaluated regularly in order to provide good

³⁶ Vetenskapsrådet (2017). Riktlinjer för sakkunnigbedömning vid Vetenskapsrådet.

³⁷ Vetenskapsrådet (2018). Utvärdering av den kliniska forskningens kvalitet vid de landsting som omfattas av ALF-avtalet.

documentation for quality-enhancing measures.³⁸ To provide such documentation, the evaluations should include analyses of why the research system produces the results it does. These evaluations are based on peer review. They use both a national and an international comparison perspective, and are based on various types of documentation, including quantitative forms.³⁹

The way forward

Quality assurance: To enable Sweden to strengthen its position as a successful research nation, it is crucial for all Swedish research to be quality assured. Sweden needs to create better quality development of research, where there are opportunities to identify important inputs that can address failings and create better prerequisites for Swedish researchers. Results from evaluations based on peer review constitute a basis for such a development.

It is therefore of central importance that all higher education institutions have a well-functioning system for quality assurance, so that the thorough peer review and follow-up that is today carried out by the governmental funding bodies also permeates the research funded by the higher education institutions' direct government funding. The higher education institutions' evaluation of the quality of their own research is a central part of the framework for quality assurance produced by the Association of Swedish Higher Education Institutions (SUHF). In combination with the Swedish Higher Education Authority's (UKÄ) work with quality assurance, there are good prerequisites for improving the quality of research at Sweden's higher education institutions.

National and international perspective: Quality evaluation from a higher education institution perspective must be complemented with national evaluation of research within different areas. With the option of national and international comparison perspectives on research, answers are provided to questions about national strengths and weaknesses within a specific area. It provides a perspective that enables national research policy measures that complement the higher education institutions' own (autonomous) choices of focus. The Swedish Research Council conducts these national evaluations. To create good prerequisites for planning and opportunities for coordination with the higher education institutions' own evaluations, the Swedish Research Council intends to establish a more complete model and a long-term time plan for thematic and subject-specific evaluations of Swedish research.

The Swedish Research Council also wishes to emphasise the need for dialogue and knowledge exchange about evaluation and quality assurance between all the actors in the research policy system.

³⁸ Förordning (2009:975) med instruktion för Vetenskapsrådet, first paragraph.

³⁹ Vetenskapsrådet (2018). "Inspel till uppdraget om kvalitetssäkring av forskning" Dnr 3.3-2018-178; Vetenskapsrådet (2018). "Remissyttrande över rapporten "Kvalitetssäkring av forskning (2018:2)" Dnr 1.1.3-2018-5653.

7. Internationalisation

- Participation in international collaborations and contexts is crucial for the quality and development of Swedish research.
- The Swedish Research Council sees a need to develop unified national strategies for internationalisation, covering both education and research, and based on coordinated analysis of the contemporary international environment.
- Research funding bodies play a particular role in stimulating research collaboration with countries that have a high level of competence and potential, but with whom the level of collaboration is low.
- Sweden should play a leading role in the process of expanding the European Research Area (ERA) and in the participation in the EU's framework programme for research and innovation.

Challenge: Sweden needs the world's research

99 percent of the world's research is conducted outside Sweden, and the Swedish research community is therefore dependent on international exchanges to promote new thinking, stimulate the exchange of research ideas and develop new research methodologies.⁴⁰ At the same time, ever greater importance is attached to research for solving societal challenges and functioning as a motor for national economy. The international aspect of this is clear, as multilateral challenges also require multilateral solutions. This is brought up in Agenda 2030 and in the declaration from Lund Revisited 2015, and is a fundamental part of the EU's framework programme Horizon 2020.⁴¹ International collaboration increases the opportunities to influence the focus and budget for international research programmes. Against this background, it is also Sweden's stated research and innovation policy to work towards increased Swedish participation in strategic international research and innovation collaborations, and to increase Swedish influence on the EU's research agenda, not least to increase the percentage of EU funds that can be applied for to the benefit of Swedish actors. For example, Swedish participation in the European Research Council's (ERC) calls has been uneven, and for some subjects also not gender equal. An underutilised potential for Sweden exists here. In a global environment where more and more countries are aspiring to become prominent knowledge nations, Sweden needs to increase its visibility as a research nation, to continue to take a place on the international arena, and to be perceived as an attractive collaboration partner and workplace.⁴²

At researcher level, much of the activity is already characterised by internationalisation. This is clearly visible in the publication patterns of Swedish

⁴⁰ Vetenskapsrådet (2018). Vetenskaplig produktion – Analys av det vetenskapliga forskningssystemet.

⁴¹ United Nations. About the Sustainable Development Goals. 2019.
<https://www.un.org/sustainabledevelopment/sustainable-development-goals/> (Downloaded 2019-04-23);
Lunddeklarationen 2015.

⁴² SOU 2018:78. Ökad attraktionskraft för kunskapsnationen Sverige.

researchers, where 68 per cent of the scientific articles published in 2016 with at least one Sweden-based author also has authors from other countries.⁴³ However, several reports are also indicating that there are considerable development opportunities.⁴⁴ Researcher mobility to and from Sweden needs to be supported (see Chapter 8 on career paths and mobility). Bibliometric analysis also shows that collaboration takes place principally with partners from the Nordic countries, Western Europe and USA, while partnerships with researchers from countries with higher institutional or cultural thresholds, such as China and the rest of South-East Asia, are under-represented.⁴⁵

The role of the Swedish Research Council: To create prerequisites for the internationalisation of research

The Swedish Research Council plays a central role in Sweden's participation in international programme and steering committees, calls for research proposals and research infrastructures, and today holds more than 200 places on international bodies. European collaboration is a central task, and, since 2015, the Swedish Research Council has therefore had one personnel member stationed in Brussels. The Swedish Research Council works for Swedish participation in the EU's framework programme for research and innovation through a large number of assignments as national experts and contact centres, and participates in multinational calls for research proposals. The Swedish Research Council also has special responsibility for Horizon 2020's pillar relating to excellent science, but the Council is also engaged in other parts, such as the societal challenges pillar. Together with Vinnova, the Swedish Research Council has a specific role of supporting the Government Offices in the negotiations ahead of the next framework programme (Horizon Europe). The European engagement plays a major role outside the framework programme too. For example, the Swedish Research Council participates in ERA-related groups and in several initiatives for joint programme initiatives (JPI), in particular in relation to antimicrobial resistance (JPIAMR), for which the Swedish Research Council hosts the secretariat.

The Swedish Research Council has bilateral collaborations with strategically important countries, such as China, India, South Korea, South Africa and Brazil. It is the Swedish Research Council's view that the formalised bilateral collaboration should be relatively limited, and focused on the countries where the need for such collaboration fulfils a clear function. For several major research nations, this need is of less importance, and researchers can themselves manage collaborations within the framework of the research projects being supported. The Swedish Research Council also gives Swedish researchers access to a large number of multinational research environments in the form of international research infrastructures (see Chapter 3 on research infrastructure).

⁴³ Vetenskapsrådet (2017). Forskningsbarometern 2017 – Svensk forskning i internationell jämförelse.

⁴⁴ Vetenskapsrådet (2017). Svenskt deltagande i Europeiska forskningsrådet, SOU 2018:3. En strategisk agenda för internationalisering; SOU 2018:78. Ökad attraktionskraft för kunskapsnationen Sverige.

⁴⁵ Vetenskapsrådet (2016). Svenskt publiceringssamarbete i ett globalt perspektiv.; Vetenskapsrådet (2013). Sweden's global connectivity in research – An analysis of international co-authorship

The Swedish Research Council is engaged in the national coordination of international collaboration, and also participates in NordForsk and other Nordic research collaboration schemes.

The way forward

Greater coordination: As was also pointed out in the 2015 edition of this report, the Swedish Research Council sees a need for a national strategy for international research collaboration, and is positive towards this being highlighted in the interim submission to the Government's internationalisation inquiry. National collaboration is key to successful internationalisation.⁴⁶ The current collaboration formats, such as EU-Sam and Int-Sam, should therefore form the basis for a development towards more proactive and strategic roles.

Needs-focused collaboration: The implementation of more strategic collaboration must be done with consideration for the needs of higher education institutions and researchers. Sweden-based researchers can usually find their own international collaboration partners, based on joint research interests or with the help of initiatives by the higher education institutions. Research funding bodies can, however, play a central role in facilitating and encouraging research collaboration with researchers also from other countries and regions, where high-quality and, in some fields, world-leading research is being conducted. Choices and deliberations of which collaboration will be of most benefit to Sweden-based researchers should be preceded by an analysis of the value to research in Sweden in the short and long term, and be linked to research policy prioritisations. Increased internationalisation also requires increased awareness among higher education institutions, researchers and funding bodies about cultural differences and ethical issues (see Chapter 10).

Proactive monitoring of the contemporary international environment: The Government's internationalisation inquiry identified well-developed analysis and monitoring of the contemporary environment as priority measures. Coordination of the analyses by relevant actors would provide more proactive monitoring of the contemporary environment, and more efficient use of resources. To ensure that correct and useable data are collected, a well-developed dialogue between research funding bodies is needed, and also between funding bodies and higher education institutions. A possible platform for such a dialogue is described in the final report by the internationalisation inquiry.⁴⁷

The attraction of Swedish research environments: Enhancing the attraction of Sweden in a research context is a many-faceted task. In addition to excellent science and high-class research infrastructure, we also need a strategy to attract both students and also junior and established researchers to Sweden (see Chapter 8). Another important part is building up and taking part in international research infrastructure, and the interactions created by such meeting places for researchers from all around the world (see Chapter 3).

Sweden and the EU: Sweden is one of the most prominent research and innovation countries in the EU, and it is therefore natural for Sweden to take a

⁴⁶ SOU 2018:3. En strategisk agenda för internationalisering.

⁴⁷ SOU 2018:78. Ökad attraktionskraft för kunskapsnationen Sverige.

leading role in the process of building up the European Research Area (ERA).⁴⁸ To become as effective and attractive a European collaboration partner as possible, the work on developing the ability of different parts of our national system to collaborate with EU and other European countries needs to continue. Participation by Swedish researchers in European collaborations is good, but can become better. Higher education institutions and research funding bodies are already working hard at making the funding and collaboration opportunities offered visible, both via the EU's framework programme and via other collaboration formats, such as JPIs and others. Increased Swedish participation requires these activities to be continued, intensified and coordinated. Sweden is today lacking a national strategy for participation in the European framework programme for research and innovation. The Swedish Research Council has identified a need for such a strategy to be produced ahead of the upcoming framework programme, and sees a role for the Swedish Research Council in this. Such a strategy would also be in line with the expressed ambitions of Sweden's new national roadmap for the European Research Area.⁴⁹

⁴⁸ Vetenskapsrådet (2018). Vetenskaplig produktion – Analys av det vetenskapliga forskningssystemet.

⁴⁹ Utbildningsdepartementet (2019). Nationell färdplan för det europeiska forskningsområdet 2019–2020. Bilaga till Regeringsbeslut, 2019-04-18. Dnr. U2019/01576/F.

8. Career paths and mobility

- A functioning and stable career path system within the higher education sector is needed in order to develop the quality of Swedish research in the long term.
- Recruitment of personnel for the higher education sector must be done using open calls, with transparent and pre-defined assessment criteria, covering both research and teaching merits, and including mobility.
- To create incentives and resources for increased use of the career development employment category ‘associate senior lecturer’, we propose that funding should increasingly be targeted towards this category.

Challenge: Higher education sector recruitment of prominent junior researchers must be safeguarded

A central requirement for the long-term quality development and competitiveness of Swedish research is that recruitment to the higher education sector must be done in such a way that the prerequisites for junior researchers to develop into prominent researchers, research leaders and teachers are enhanced. This assumes functioning career paths. It also assumes a system where researchers are assessed on merit in an equal and transparent way, and a system that stimulates and values international and national mobility.

Since 2000, the Swedish higher education sector has expanded greatly, which has primarily been expressed in there being more researchers, but not in better conditions for individual researchers. The research and teaching personnel in employment categories that normally require a doctoral degree has increased by 86 per cent since 2001, which represents a growth of 5 per cent per year. The increase in higher education personnel has been particularly large among junior researchers and teachers. The increase has primarily been in the employment categories ‘researcher’ and ‘postdoc’ (both temporary employments), which together have increased from 17 per cent of the personnel with doctoral degrees in 2001 to 27 per cent in 2017. At the same time, the career development category ‘associate senior lecturer’ and the formerly used category ‘research assistant’, aimed at providing junior researchers with secure and predictable conditions, have not at all increased to the same extent. Together, these two employment categories represented 8 per cent of the personnel with doctoral degrees in 2001, and this decreased to 5 per cent by 2017. Just as in many other countries, there has also been a shift towards an ever increasing percentage of postdoc and researcher positions.

The situation for junior researchers is thus increasingly characterised by insecurity and temporary employment.⁵⁰ One of the reasons for this is that research is largely an idea-borne activity and that many junior researchers are attached to specific research projects – funded by various sources – which are conducted by the project leaders who have formulated the research ideas. Specific individuals can

⁵⁰ SOU 2016:29. Trygghet och attraktivitet – en forskarkarriär för framtiden, p 155 ff.

therefore not be moved between different activities and projects within the higher education institution, in the same way as is possible in other types of operations. This is the background to the temporary employment positions that characterise the early years of researchers' careers. Positions of this type can be filled without any requirement for a formalised process to assess merit. In other words, a researcher can be part of the research system through temporary and short project positions for several years without any assessment being made of the merits and skills that determine whether the researcher has the prerequisites for pursuing a long-term career within higher education. On the other hand, there is a lack of incentive and difficult to find the time and space for junior researchers to develop their research competence within the framework of their employment. The consequence is that recruitment to higher education is not always done in such a way that it is the prerequisites for developing into a prominent researcher and teacher that determine the outcome; instead, it can be a question of who is in the right place at the right time.

This also impacts on mobility, as junior researchers often feel that it is safer to stay at home to monitor employment opportunities than to go off and obtain important experience from strong research environments abroad. Surveys show that Swedish researchers and teachers are less internationally mobile than several successful research countries, such as Switzerland, Denmark and Netherlands, and that there is a tendency towards decreasing international mobility, both in Sweden and in the EU as a whole. This applies not least within clinical research. The reasons for the lack of interest is not just worry about falling behind on the career ladder, but also uncertainty about moving with, or being separated from the family, as well as the adjustment and insecurity inherent in establishing oneself in a new country.

Against this background, there is a need both for structures and funding instruments that promote mobility, and for initiatives aimed at removing the obstacles to mobility. Mobility creates opportunities for exchange of thoughts and ideas, techniques and methods, study material and new research findings between researchers in different parts of Sweden and the world.⁵¹

The role of the Swedish Research Council: To support different stages of careers

To have the opportunity to develop independence as a researcher, it is important that junior researchers also have the opportunity to apply for external grants awarded in national competition and following stringent quality control. Here, the grants aimed straight at junior researchers by external funding bodies play a quality-driving role. In order to promote the development of junior researchers, the Swedish Research Council has a number of different grant forms, designed to ensure researchers are

⁵¹ MORE3 study – Support data collection and analysis concerning mobility patterns and career paths of researchers, IDEA Consult, WIFO and Technopolis 2017; Vetenskapsrådet (2018). Utvärdering av den kliniska forskningens kvalitet vid de landsting som omfattas av ALF-avtalet; Vetenskapsrådet (2019). Uppföljning och analys av Vetenskapsrådets bidragsform internationell postdoktor; Pleun van Arensbergen (2014). Talent Proof: Selection Processes in Research Funding and Careers; Rathenau Instituut. Den Haag; SOU 2018:78. Ökad attraktionskraft för kunskapsnationen Sverige; Vetenskapsrådet (2016). Rekrytering av forskare och lärare med doktorsexamen vid svenska lärosäten; Vetenskapsrådet (2015). Forskningens framtid! Svenska forskares mobilitet.

able to develop their research careers gradually. The purpose of the international postdoc grant is to give newly qualified researchers with a doctoral degree from Swedish higher education institutions the opportunity to expand their networks and competences by working abroad under secure employment conditions. The next step involves calls for starting grants, in particular within natural and engineering sciences and within medicine and health. It has been shown that these are areas where researchers at an early stage of their careers have more difficulty competing for project grants. After this follows the consolidator grant, which aims to give the most prominent junior researchers the opportunity to consolidate their research and broaden and deepen their activities.

The Swedish Research Council has a positive attitude to researchers awarded its grants also doing teaching in conjunction with their research. In this way, the research is communicated actively to students, and can reach further out into society.

The way forward

For a career in higher education to be attractive to young, promising researchers and teachers, it is necessary to have a transparent and clear career system, with great predictability. The quality requirements must be stringent, with transparent and predictable grounds for assessment that include both scientific and educational merits. Junior researchers shall be encouraged to take initiatives that will promote their development as researchers, for example by spending a period abroad, without feeling that they are jeopardising their future employment opportunities. At the same time, the merit accumulation system must take into account that the prerequisites differ within different areas, for example for clinical researchers and personnel working at research infrastructures. To achieve long-term academic competence enhancement that creates space and incentives for research within day-to-day healthcare work, Swedish health and medical care personnel must be given better prerequisites for conducting research. It is also important that career systems and career support are designed in such a way that they interact with each other.

The Swedish Research Council sees a need for increased use of the career development employment category 'associate senior lecturer' and other teaching positions for temporarily employed researchers. To achieve this, further incentives and resources are needed for higher education institutions to recruit prominent junior researchers to these positions. The Swedish Research Council proposes that the Government should formulate goals that result in such incentives. To further contribute to career development employment being used more, the Swedish Research Council will review, in dialogue with higher education institutions, the terms and conditions and employment formats for certain grant forms so that they are adapted to those who are recruited or in the process of being recruited. In this way, the initiatives by higher education institutions and funding bodies can interact.

Finally, we need to ensure that external research funding and employment processes are designed to promote international and national mobility among junior researchers and teachers.

9. Gender equality

- A gender-equal research system is needed to take advantage of all competence, which contributes to increasing the quality of research.
- The responsibility of higher education institutions to promote gender equality using recruitment goals, follow-up and gender equality integration should be developed.
- Gender equality must be integrated in all parts of planned strategic initiatives relating to research, and measures to encourage more individuals of the under-represented gender to choose areas with skewed gender distribution must intensify.

Challenge: A gender-equal research system

Gender equality promotes quality and renewal within research, by enabling competence and experience among both women and men to be utilised. This is not fully achieved currently. Increasing gender equality in Swedish research is therefore an important quality-enhancing measure.

The percentage of women among those with newly awarded doctoral degrees and within various employment categories in higher education has gradually increased over the last few decades, and is approaching 50 per cent on average for all academic subjects. Of the total number of full-time employees with research and teaching tasks in 2017, 13 500 were women (45 per cent) and 16 500 were men (55 per cent).⁵² In 2001, 37 per cent were women and 63 per cent were men, which means that the gender distribution has become more even over time. In 2017, the greatest inequality in gender distribution existed for the age group 65 years and over (2 700 persons), where 65 per cent were men and 35 per cent women. Gender distribution varied between the different research subject areas. Within agricultural sciences and veterinary medicine, social sciences and humanities, and art, the gender distribution was in principle even, while more men than women were active within the areas of natural sciences and engineering sciences, where men represented 75 per cent and 71 per cent respectively. In medicine and health sciences on the other hand, women were in the majority with 59 per cent.⁵³

Of the Swedish professors, 28 per cent are women. It is positive that the percentage of female professors has increased by 1 per cent compared to last year, and by 14 per cent since 2001. At the same time, several longitudinal studies show that women find it more difficult to advance to the highest positions within academia.⁵⁴

⁵² Of the research and teaching personnel, 72 per cent had completed third cycle higher education. Universitetskanslersämbetet (2018). Personal vid universitet och högskolor, (UF23SM 1801 Sveriges Officiella Statistik, Statistiska meddelanden). UKÄ and SCB, Stockholm.

⁵³ The percentages are based on the number of full-year employees. Ibid.

⁵⁴ Ibid.

In the group that were awarded doctoral degrees in 1991, 8 per cent of the men, but only 4 per cent of the women, were employed as professors within a 12-year period. The fact that men more often become professors applies for most subject areas, and career advancement also takes longer for women than for men.⁵⁵

The role of the Swedish Research Council: To work towards increased gender equality

Through its work towards gender-equal distribution of support for research, the Swedish Research Council contributes to gender equality in higher education. For many years, the agency has set goals for gender-equal distribution, and has monitored the results carefully.

Over the last ten years, the Swedish Research Council has also actively studied how its internal processes function, from a gender equality perspective, in the assessment of applications for research grants. The intention has been to investigate the opportunities to improve procedures, instructions and other aspects. The results have been published in Swedish and English, and many of the recommendations have been implemented by the agency. The reports have been recognised, nationally and internationally, particularly by other research funding bodies. Many of them have chosen to conduct studies similar to those conducted by the Swedish Research Council, and a number of higher education institutions have requested further information in order to possibly do something similar. Through the reports, the Swedish Research Council has contributed to increased knowledge of how gender equality perspectives can be made visible, and has contributed with examples of how the quality of the scientific assessment can be increased by making it gender-neutral.⁵⁶

There are studies that show women have been disadvantaged by initiatives relating to strong environments and excellent researchers. Women have received a significantly lower percentage of these funds than their percentage of professorships would justify.⁵⁷ A recent study indicates that the women who have applied for the Swedish Research Council's research environment support and excellence initiatives have not been disadvantaged in the agency's assessment processes. On the other hand, fewer women than men have applied and been awarded this type of funding. These percentages are, however, proportional to the skewed gender distribution at the higher education institutions in the target groups for these calls.⁵⁸

The way forward

To speed up the development towards gender-equal higher education, the Swedish Research Council wishes to make three recommendations. They are primarily aimed

⁵⁵ Vetenskapsrådet (2015). Karriärstruktur och karriärvägar i högskolan.

⁵⁶ Vetenskapsrådet (2017). En jämställd process – jämställdhetsobservationer. See also the corresponding publications, (2009), (2012), (2013) and (2015).

⁵⁷ Sandström, U. och Wold, A. (2015). Excellenssatsningarna – belöning för kön eller toppforskning? i Tänka vidare. Forskning, finansiering, framtid; Riksbankens Jubileumsfonds årsbok 2015/2016. Riksbankens Jubileumsfond, Stockholm.

⁵⁸ Vetenskapsrådet (upcoming). Jämställdhet i Vetenskapsrådets miljöstödd och excellenssatsningar.

at the Government, but also have a bearing on higher education institutions, the Swedish Research Council and other research funding bodies. The Swedish Research Council wishes to emphasise that the work towards gender equality is also intended to promote equality and diversity in higher education.

A clearer gender equality mandate: In addition to the current recruitment targets, each higher education institutions should be mandated to follow up and report on gender equality, divided up into different personnel categories and scientific fields. Particular attention should be paid to new recruitment, where the higher education institution should be mandated to set its own recruitment targets. The distribution of women and men among temporary employees should also be reported, as should the distribution of women and men in positions with emphasis on teaching and research respectively. All higher education institutions should analyse their distribution mechanisms for internally funded research, and create incentives for utilising great scientific competence, irrespective of gender. Consequences for successful and unsuccessful gender equality work should be introduced. This could, for example, be done in conjunction with the auditing of higher education institutions' quality work.

Integration in all strategic initiatives: Gender equality shall be considered, both when choosing areas for initiatives, and in the formats for calls, preparation and follow-up of initiatives decided upon. As strategic initiatives of different kinds have often resulted in male researchers receiving research grants to a greater extent than female researchers, it is of the utmost importance that gender equality is integrated in all parts of strategic initiatives right from the planning stage.⁵⁹

Initiatives towards areas with skewed distribution: In some research areas, the gender distribution is skewed. Here, measures to deal with this must be intensified, and this is primarily the duty of the higher education institutions. What is done should be of a structural nature, so that persons of the under-represented gender who apply for the area can also feel welcome. The Swedish Research Council and other research funding bodies can also investigate what instruments may be suitable for encouraging more persons of the under-represented gender to apply for grants – from targeted information initiatives to targeted research grants.

The Swedish Research Council has found, in conjunction with calls for research grants, that the gender distribution among applicants in some research fields is skewed, with women often being the under-represented group. There are examples of funding bodies (Vinnova and the Swedish Foundation for Strategic Research) that have issued specific calls aimed at under-represented genders. This might be a strategy for encouraging women to apply for research grants, and in the longer term encourage them to continue working as active researchers. Another option is targeted information initiatives towards women within certain research areas. The Swedish Research Council can also investigate the option of adapting its own review processes. In some research fields, the competence of the applicant is emphasised, which the review panels measure by assessing the researchers' overall merits. Because of this, there is a risk that the inequality that prevails in academia, with

⁵⁹ Sandström, U., Wold, A., Johansson, B., Ohlsson, B. och Smedberg, Å. (2010). Hans Excellens: om miljardsatsningarna på starka forskningsmiljöer, rapport 2010:4. Delegationen för jämställdhet i högskolan, Stockholm.

more men in leading positions, is reproduced and perhaps even reinforced, via the Swedish Research Council's review processes.⁶⁰

⁶⁰ Vetenskapsrådet (2017). En jämställd process – jämställdhetsobservationer. See also corresponding publications (2009), (2012), (2013), and (2015).

10. Ethics, good research practice and scientific misconduct

- Processes for research ethics reviews and approvals must work in a satisfactory and uniform way across the entire scientific field, and within international collaborations.
- Governmental and higher education research principals need to develop clear processes for handling suspected scientific misconduct within the areas that fall outside the mandate of the new government agency being established to deal with cases of scientific misconduct.
- A national code of conduct for good research practice should be established.
- Awareness and knowledge about research ethics issues need to be strengthened.

Challenge: Increase awareness and knowledge about research ethics

Ethics considerations and guidelines are a cornerstone for trust in research, for the quality and implementation of research, and for how research results can be used in a responsible manner to develop our society. Integrity in research entails factors such as conducting research using verifiable methods, complying with rules and guidelines, and reporting results objectively, honestly and openly.⁶¹ The early focus of research ethics was on protecting patients, research subjects and laboratory animals in medical research. In recent years, further areas, such as stem cell research, nano research, gene technology and research into artificial intelligence, have been added as areas where ethics issues are particularly recognised.

Developments in recent years have shown that there is an increased need for awareness and knowledge of research ethics issues, and for review processes that function for the entire the scientific field. This also includes research ethics reviews of international research collaborations, as different countries have differing rules. The new Swedish Ethical Review Authority will play an important role in this work, and provide prerequisites for making ethical review practices more uniform.⁶² The satisfactory functioning of processes for research ethics reviews is not just the responsibility of the Swedish Ethical Review Authority, but a joint responsibility together with the scientific councils as well as higher education institutions.

⁶¹ National Institutes of Health. What is Research Integrity. 2019. https://grants.nih.gov/policy/research_integrity/what-is.htm (downloaded 2019-04-23)

⁶² Prop. 2017/18:45. En ny organisation för etikprövning av forskning som avser människor., Direktiv 2017:127. Kommittédirekt: Inrättande av Etikprövningsmyndigheten.

The role of the Swedish Research Council: To safeguard and recognise ethical issues

The Swedish Research Council works in several ways on issues of research ethics. The Swedish Research Council considers maintaining an active dialogue on research ethics issues to be an important task, and has had an expert group on research ethics since 2001. The expert group deals both with agency-specific issues and more overarching issues relating to research and researcher ethics. The expert group also has the task of producing documentation for publications in the area, and has for example initiated the booklet on Good Research Practice.⁶³

The Swedish Research Council also has an expert group on laboratory animal science. Its tasks includes assisting the Swedish Research Council with monitoring, analysis and information on the laboratory animal area in a national and international perspective.

Research ethics issues are, of course, also considered in the Swedish Research Council's funding of research. Researchers who apply for grants from the Swedish Research Council must report whether ethical issues arise in their research, and how they plan to deal with any ethical issues that may arise.

The way forward

Clearer processes and guidelines: The Swedish Research Council welcomes the proposed management of cases of suspected scientific misconduct, where higher education institutions will no longer be investigating themselves.⁶⁴ A new, independent scientific misconduct agency is to be established. When suspicion arises of scientific misconduct in the form of fabrication, forgery or plagiarism (FFP), the scientific misconduct agency shall be responsible for investigation and decisions according to clear regulations. The Swedish Research Council is also very positive towards the proposed legislation requiring researchers to be responsible for complying with good research practice, and for governmental and higher education research principals to have overall responsibility for ensuring this is done. The Swedish Research Council further considers it to be of great importance that research principals produce clear procedures for handling any suspected scientific misconduct outside the scope of the FFP area. The governmental research councils should jointly produce guidelines for how to act when scientific misconduct or other deviations from good research practice have been established.

Adaptation of legislation: Safeguarding personal integrity is central for the credibility and legitimacy of research. With this consideration, it is still important for Swedish legislation to be designed to facilitate research for the benefit of society. Among other aspects, opportunities to use existing data and collect new data (following ethical review) need to be safeguarded. Adaptation of Swedish legislation and legal practice to the European General Data Protection Regulation should be made with consideration for and knowledge about the needs of research.

⁶³ Vetenskapsrådet (2017). God forskningssed.

⁶⁴ SOU 2017:10. Inquiry: "Ny ordning för att främja god sed och hantera oredlighet i forskning", Vetenskapsrådet (2015). Vägval för framtidens forskningssystem – mål och rekommendationer.

A new code of conduct: It is important to continuously raise and increase the awareness and knowledge about research ethics issues. Several initiatives could serve this purpose: The Swedish Research Council and the new scientific misconduct agency, together with the research community, should draw up a code of conduct for good research practice. Here, it is important to consider the international aspect. Courses and workshops are also important tools for increasing awareness and knowledge about research ethics. These should be held continuously, be adapted to different subjects and local needs, and preferably be coordinated nationally. The Swedish Research Council will also work towards ethics issues being introduced at an early stage of the research process when new areas are established.

11. Open access

- The transition to open access to publications and research data requires dialogue between research funding bodies, higher education institutions and researchers.
- The transition to open access to scientific publications must be made with focus on quality in publications.
- Higher education institutions and funding bodies need to adapt their guidelines for evaluating merit, so that these support a transition towards open access.
- Sweden needs a national strategy for open access to research data.
- In order to successfully transition to open access to research data, increased resources and new technical support functions are needed.

Challenge: Complexity and resources

The transition to open access to scientific results must be made on the basis of analyses of how this impacts on research and the researchers. This is a complex, global work of change, which is dependent on everybody who is affected by the change taking part in the process. At the same time, the development must occur with respect for academic freedom.

There are currently certain obstacles to researchers publishing results and data with open access. The obstacles consist of factors such as high cost and lack of infrastructure. If researchers are denied the choice of publication channel, this will also impact on how scientific merit accumulation is done. Further obstacles and challenges that need solving to enable the goal of open access to be achieved are identified in the proposal for national guidelines for open access to scientific information, submitted by the Swedish Research Council in January 2015.⁶⁵

The development towards open access is international, and comprehensive work is in progress at European level on the transition to open access to both publications and research data. Open access to scientific results is expected to become part of the EU Commission's next research programme, Horizon Europe.

Good data management supported by infrastructure and functions to support open access to research data are basic prerequisites for research data to be created, quality controlled, stored and made available openly. This in turn contributes to qualitative data becoming utilised in new contexts. The EU Commission's 'PSI Directive' will be expanded with requirements on member states to develop policies/strategies for making research data available. The EU Commission has also produced a recommendation for member states to establish and implement strategies for dissemination, free access to and storage and re-use of research results and research data that are the result of publicly funded research.⁶⁶ The EU Commission has also initiated the European Open Science Cloud (EOSC), which is a joint, open and

⁶⁵ Vetenskapsrådet (2015). Förslag till nationella riktlinjer för öppen tillgång till vetenskaplig information.

⁶⁶ Directive 2003/98/EC of the European Parliament and of the Council of 17 November 2003 on the re-use of public sector information; Commission Recommendation (EU) 2018/790 of 25 April 2018 on access to and preservation of scientific information.

virtual environment for supplying services for storage, management, sharing, analysis and use of research data.

During a build-up phase, the transition to open access to research data will entail costs, for example for storing, preserving and making research data openly available. There will also be costs for infrastructure and support functions, for example for creating conditions for good data management. There are needs for both technical infrastructure (such as virtual desktops, identity federation, and archiving/storage) and infrastructure for research (such as HPC, Cloud, active storage) to implement the FAIR principles for research data (Findable, Accessible, Interoperable and Reusable).

One of the identified obstacles to a transition to open access to publications concerns guidelines for evaluating merit for higher education institutions and funding bodies, while another obstacle relates to how the transition from a subscription-based publication system to one that is openly accessible can be implemented and funded. Open access to books, follow-up of funding body requirements and financial and technical support for periodicals that publish with open access are other challenges that the Swedish Research Council has identified, and that have now been investigated via the National Library of Sweden's coordination assignment, which was reported to the Government on 19 March 2019.⁶⁷

In autumn 2018, Science Europe launched Plan S, which links to the Council conclusions agreed on by the EU member states' research ministers in 2016.⁶⁸ Plan S has the goal of immediate open access as from 2020, a time plan that has now been slightly modified in the implementation plan presented. The Swedish Research Council shares the long-term ambition for open access included in Plan S, but has not underwritten the plan. The transition to open access must be made in a way that both safeguards the scientific quality of the publications, and also ensures that scientific publications can be used to evaluate the merit of researchers in a way that is fair. To achieve this, a more developed dialogue is needed with researchers, who form the most important group of actors in the proposed system change. The Swedish Research Council will drive the point that higher education institutions and funding bodies must create a system where research is evaluated on its own merits, and not according to the prestige of the publication.

The role of the Swedish Research Council: To actively communicate, discuss and work towards open access

The Swedish Research Council fills the role of the EU Commission's National Point of Reference (NPR) for open access to scientific information. The NPR functions as the EU Commission's link to national coordination of the area. The Swedish Research Council takes active part in Science Europe, via working parties handling issues relating to open access to both scientific publications and research data.

⁶⁷ Kungliga biblioteket (2019). Omställningen till ett öppet tillgängligt vetenskapligt publiceringssystem.

⁶⁸ The European Union Council's conclusions on the transition towards an open science system, document 9526/16. Adopted on 27 May 2016 in Brussels.

The Swedish Research Council has the task of coordinating the work of introducing open access to research data, and in December 2018 we reported on an assignment to produce criteria for assessing to what extent research data fulfils the FAIR principles.⁶⁹ The Swedish Research Council is also responsible for the metadata tool RUT (Register Utiliser Tool), which improves accessibility to register data for research purposes. RUT is being developed with functionality to support good data management according to the FAIR principles, which contributes to improved quality and documentation at the data owners.⁷⁰ The National Library of Sweden has the corresponding task concerning coordination and FAIR principles in relation to publications.

The Swedish Research Council also works actively on issues relating to EOSC, funds a number of research infrastructures, including e-infrastructures, and operates Sunet, which in addition to being responsible for the university data network also offers services, such as storage, based on the needs of the research community.

Since 2010, the Swedish Research Council has required that those awarded grants must publish with open access (not research data). Researchers may include costs of publication when applying for research grants. The Swedish Research Council has participated in the National Library of Sweden's coordination assignment work, takes active part in the debate on the transition to open access to publications, and is involved in a dialogue with research funding bodies and higher education institutions on issues such as Plan S. The Swedish Research Council is also involved in the ongoing dialogue at national level with the major publishers. This dialogue is currently focused on transformative agreements including both publication and open access, known as 'reading and publication agreements', to replace today's situation where you pay separately for reading rights and publication fees (or 'article processing charge', APC).

The way forward

Dialogue with all actors: The Swedish Research Council supports the development towards open access to scientific information, in line with Swedish research policy prioritisations. Like the Government, the Swedish Research Council considers that open access increases the chances of research results being used by societal institutions as well as by business organisations, but also by research per se: Faster dissemination of research results to more researchers contributes to an increase in quality. The transition to open access does, however, require a dialogue between research funding bodies, researchers and libraries, and the managements of higher education institutions.⁷¹ There is also a great need for dialogue within higher education institutions, as challenges relating to areas such as publication and merit accumulation exist within all scientific disciplines. The dialogue held at national level with the major publishers is important and aims to facilitate the transition through 'transformative agreements', which cover both publication costs and reading rights. The Swedish Research Council participates in national and

⁶⁹ Vetenskapsrådet (2018). Kriterier för FAIR forskningsdata.

⁷⁰ RUT is accessed via the Swedish Research Council's website www.registerforskning.se.

⁷¹ Kungliga biblioteket (2019). Omställningen till ett öppet tillgängligt vetenskapligt publiceringssystem.

international collaborations to support the development of high-quality periodicals that publish with open access (see for example DOAJ). The Swedish Research Council also follows up publication patterns to ensure that publication is done through openly accessible channels according to our grant terms and conditions.⁷²

Merit evaluation that supports publication with open access: The Swedish Research Council wishes to contribute to higher education institutions and funding bodies jointly creating a system, based on international developments, where research is evaluated on its own merits, and not according to the prestige of the publication.⁷³ It is important that the merit accumulation system does not discriminate against publication in periodicals that apply the principle of open access. The solutions developed must be sustainable, be based on the researchers' terms, and support free, independent research. They also need to take into account the fact that the prerequisites differ significantly between different scientific fields.

A national strategy for open access to research data: To manage the transition to open access to research data, Sweden needs a clear national strategy. This also links well to the directives and recommendations produced by the EU Commission.

Create support functions. Technical developments and the growing amount of research data place demands on new functionalities and increased capacity, for example in digital infrastructure. We must be able to ensure that data is managed in a way that fulfils the requirements for accessibility, sustainability and reusability. This also generates requirements for support functions for data management, in the form both of persons that researchers can contact for support on issues relating to data management and open access (such as data scientists and data stewards), and technical functions.

Set aside funds: The increased costs associated with the transition to open access need to be met. In terms of research data, for example, this relates to resources to build up competence and infrastructure within academia for the new roles that are necessary to fulfil the requirement for FAIR data management. In terms of publications, this relates in particular to support of the development towards a new business model that is not based on subscription fees, but on publication fees. In this context, it is urgent to create a system for control of both the quality delivered by the publishers, and also cost developments.

⁷² Directory of Open Access Journals, DOAJ, <https://doaj.org/>.

⁷³ The Declaration on Research Assessment (DORA): <https://sfedora.org/>.

12. Science communication

- The need for science-based knowledge and understanding of the scientific process is increasing.
- Science communication efforts should be strengthened and coordinated, so that researchers, higher education institutions and research funding bodies can complement each other, and thereby improve the quality of communication and increase the impact of research.
- Infrastructure for knowledge dissemination needs to be developed, to make it easier for both researchers and knowledge communicators to communicate research results.

Challenge: Increased demand for scientifically based knowledge

Digital developments have increased the opportunities for researchers and other actors to communicate and reach out to large groups in society. Access to information creates opportunities for participation and influencing. This contributes to strengthening democracy. Research-based knowledge, societal development and citizens' need for participation in this development are heavily interlinked. Our ever more complex and knowledge-based society means that both decisionmakers and the general public have an increased need for science-based knowledge. Science communication is a means of ensuring research-based knowledge can reach out to the general public, and thereby prevent unfounded statements from having an impact. At the same time, cuts in the media sectors have resulted in the room for scientific knowledge communication decreasing. The work carried out by individual actors within the research system, aimed at reaching out to decisionmakers and the general public, is therefore very important. But it needs to be better coordinated.

The role of the Swedish Research Council: To create prerequisites for science communication

The Swedish Research Council and other research funding bodies play an important role in the communication of research and science. The Swedish Research Council is responsible for national coordination of the communication of research and research results. The aim is to create good prerequisites for research results to reach out outside academia, and to promote a dialogue and interaction between researchers and society as a whole. The initiatives aim to strengthen trust in research and research-based knowledge. The work is conducted both at policy level and on a more concrete level. The Swedish Research Council develops and provides channels, and provides support and tools for researchers in their work of communicating and explaining their research and its results.

The way forward

To strengthen the work with science communication, we need joint national platforms for editorial collaboration between researchers and knowledge communicators. By better utilising parts of the work carried out by actors within the research system, prerequisites exist for developing such infrastructure for knowledge dissemination to both decisionmakers and the general public. There are good examples from other countries of editorial collaboration between researchers and knowledge communicators that work both towards the parliament (United Kingdom) and towards the general public (Denmark).⁷⁴ Continuing to strengthen national coordination of the work of communicating research is important

in this context. The coordination should also include reviewing the structures for giving scientific advice to decisionmakers. Here, the Swedish Research Council has a central role.

Researchers within different disciplines have differing prerequisites and needs for communicating their research. The trend towards more open and ever more accessible science is a common feature of all research, however. Communication that stretches beyond scientific publication and is aimed at target groups outside the own scientific field requires time, but also knowledge about tools and channels. Researchers who engage in dialogue with the public and disseminate their results should receive adequate support and recognition from both research funding bodies and higher education institutions.

Together with other actors, the Swedish Research Council will review how support for strengthening the work of researchers to communicate their research can be developed, and how such work can be rewarded. Examples of how this might be done is through education, support structures or financial support. To get a clearer picture of science communication as a research area, the Swedish Research Council will also conduct a mapping of the area.

⁷⁴ See for example United Kingdom's POST (Parliamentary Office of Science and Technology, www.parliament.uk/post) and NCCPE (The National Co-ordinating Centre for Public Engagement, www.publicengagement.ac.uk/); Denmark's Videnskab.dk, www.videnskab.dk.

In this report, the Swedish Research Council presents challenges and ways forward for the Swedish research system. The report is based on the report *Direction to the Future Swedish Research System* published in 2015, and is intended to constitute underlying documentation for the Swedish Research Council's upcoming work and input into Sweden's research policy, and for a broad discussion about the importance of research, and how it is best conducted and funded.

The report has been produced by a team representing all departments of the Swedish Research Council, in close collaboration with the Swedish Research Council's director general, executive council, board, scientific councils, councils and committees.

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The Swedish Research Council has a leading role in developing Swedish research of the highest scientific quality, thereby contributing to the development of society. Besides research funding, the agency advises the government on research-related issues and participates actively in the discussions to create understanding of the long-term benefits of research.