Rathenau Instituut

NWO programmes for curiosity-driven research

Possible bases for budget distribution

Report

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Foreword

This report is about how the budget for curiosity-driven research is distributed across four groups of scientific disciplines. NWO has two programmes for this purpose: the Open Competition and the Talent Programme, known for the Veni, Vidi and Vici grants. Competition for these research budgets is fierce and the award rates vary considerably across disciplines. Consequently, several discipline groups are dissatisfied with the current budget distribution.

In both programmes, honouring grant requests should be done carefully. For years, NWO has used the same procedure of making an initial distribution across four areas of science, each covering a group of disciplines. Anno 2023, this division is mainly based on historically determined proportions. This raises the question: what is the basis for such a division? This question was posed to us by NWO and is addressed in this report.

One practicable option is to base the distribution of the available research budget on the level of demand for funding. However, our desk research and interviews at home and abroad revealed that such a basis does not do justice to other considerations. For example, it may be desirable to also make budget allocation dependent on variables that measure quality or impact of research, but this approach could be subject to practical obstacles. An additional issue is dealing with funding applications for research that covers different scientific domains. At NWO's request, we also offer ideas on this issue.

Prof Eefje Cuppen
Director Rathenau Instituut

Summary

The questions asked in this study
The reason for this publication is that NWO has asked the Rathenau Instituut to investigate possible bases for distributing budget for free, curiosity-driven research. NWO has two instruments for funding that type of research: the Open Competition and the Talent Programme. NWO distributes the available funds across four domains:

i) exact and natural sciences (ENW),
ii) social sciences and humanities (SGW),
iii) applied and technical sciences (TTW)
iv) medical sciences (ZonMw).

In addition, NWO has asked the Rathenau Instituut to conduct research on how to determine the share of the budget for cross-domain research.

The current division between the domains has grown historically; there is no specific basis for it. All budget applications are considered within one of the four domains. There is currently no separate assessment procedure for proposals that cross domain boundaries.

Overview
Our research shows that stakeholders consider the distribution of resources primarily from two perspectives: equitability and effectiveness. A basis for budget distribution should help achieve a distribution that is perceived as both fair and effective. Moreover, a basis should be practical: the indicators on which it is based should both adequately measure relevant arguments and have data available.

The question about cross-domain research was prompted by the observation that, nowadays, many promising developments fall within the intersection of disciplines and domains, including in basic research. The current division of domains may hinder these developments.

A basis for budget allocation ideally takes into account a number of complicating factors:

i) the cost of research varies widely between domains (depending on the method of research and the resources needed for it: infrastructure, data, computing power);
ii) available sources of funding vary (the availability of donations, private funding, international funds);
iii) The importance of stability and a long-term perspective.

Other countries

To get an idea of possible bases for budget allocation, we consulted public research funders (research councils) in a number of surrounding countries. The councils differ in the scope of their task (only funding academic research, or also development and innovation) and in their position vis-à-vis their own funders. This makes comparison between countries difficult. For instance, in the UK, Norway and Sweden, councils' spending is strongly determined by the priorities set by ministries. The issue of budget allocation across domains is, therefore, less of an issue.

Although all the research funders we consulted consider the question of a good method of distribution relevant, the actual distribution across the countries we examined appears to be largely historically determined and quite stable. We did not find that the distribution in other countries leads to much controversy. Where a council uses a method for budget distribution, it is relatively simple and aimed at gradually adjusting the distribution to align with developments in research costs and demand for funding.

A possible explanation for this can be found by looking at the procedures used in other countries: not setting specific deadlines for submitting grant applications, limiting opportunities for resubmission of proposals, and facilitating crossovers.

Types of bases for funding

We distinguish different (groups of) potential bases for budget allocation, based on:

- the demand for research funding,
- the quality of research, and
- the impact of research.

Bases for funding based on demand for research funding

The available research budget could be distributed based on actual or potential funding demand from scientists. Higher demand from a domain could justify a larger share of the budget. This demand for funding can be measured directly, by looking at actual applications, or indirectly, by looking at the numbers of completed PhDs in a domain, scientific staff, or research output. Depending on the weight given to such indicators, their use can be expected to lead to smaller or larger shifts in the budget distribution in favour of the domains with the lowest chances of being honoured.

Several remarks can be made about available indirect indicators. For one, PhDs in the medical domain are less likely to choose a research career than PhDs in other domains. Secondly, scientific staff in the SGW domain are appointed with less research time on average than those in the ENW domain. Lastly, publication

cultures in the various domains differ greatly, so that indicators for scientific production based on publication data are not comparable.

Bases for funding based on quality or impact of research in a domain

The distribution of the available research budget could also be based partly on the quality of research within a domain, or its impact. Higher quality and/or more impact of a research project could legitimise a larger share of the budget. But, indicators of quality and impact have important limitations. Publications and citations measure scientific quality and scientific impact only indirectly and partially; they are yardsticks that measure only certain aspects of quality and impact. Moreover, because of the large differences in research practices, they are not suitable for comparing domains.

Cross-domain applications

To better accommodate cross-domain proposals, we see two possibilities:

i) a structural adjustment in the form of a separate facility for applications, or
ii) procedural adjustments to properly accommodate these proposals within existing structures.

In principle, it is possible to allocate part of the total budget for cross-domain applications and develop separate assessment procedures for these applications. The alternative is creating more tailored assessment within the current domains. Possibilities include giving applicants influence on which assessment panels assess their application, or decoupling assessment from the question of which domain funds a proposal.

How to proceed

Whether a budget allocation is fair and effective cannot be determined by looking at the basis for budget distribution. The order should be the other way around: an idea of what is equitable and effective determines which indicators to include in a basis. However, the number of available indicators is limited and possibly insufficient to arrive at a satisfactory basis, especially if it has to include quality and impact of research in addition to demand for resources.

In light of this, several other interventions are worth considering, including balancing procedures across domains, limiting opportunities to submit proposals repeatedly, and promoting more coordination among research grant applicants.

A more radical option would be to place the Talent Programme, and perhaps the Open Competition, outside the matter domains.

Content

Introduction

In late 2022, NWO asked the Rathenau Instituut to conduct a study on possible bases for the distribution of NWO funds for the Open Competition and the Talent Programme. The aim of the study is to identify options and provide insight into the advantages and disadvantages of different bases.

The method of distribution of the available budget among the four NWO domains, as used in recent years, has developed historically. The question of what the rationale behind the distribution is, and whether it should be based on more of an explicit basis, is being discussed again at each funding round. In this study, we use the term 'basis for funding/grant distribution' to mean one or more variables in a functional relationship: a formula.

Motivation

There are several reasons to address this issue now:

- Some stakeholders feel that the distribution of funds has become unbalanced over time. They do not perceive the current distribution as fair because success rates vary widely between domains.
- For the two instruments mentioned, the budget has been substantially increased by 2023. This raises the question of whether the additional funds should be distributed among the domains according to the same distribution key as the existing budget.
- NWO distributes funds for the Open Competition and the Talent Programme across four domains, each of which encompasses a number of related disciplines. Developments in science (and society) also – and perhaps increasingly – demand research that transcends domain boundaries. There is no separate counter for cross-domain research in the current system. A current question is how a basis for budget distribution could best accommodate this research.

Research questions

NWO's Governing Board (BoG) has expressed its intention to reflect in 2022-2023 on the distribution of NWO's Open Competition funds among the four NWO divisions of exact and natural sciences (ENW), social sciences and humanities (SGW), applied and technical sciences (TTW) and medical sciences (ZonMw). A similar question can be asked for the other major NWO programme implemented by

the domains: the NWO Veni/Vidi/Vici talent programme. The BoG has asked for external advice on this distribution issue.

Thus, NWO has formulated the following questions:

1. What principles can NWO apply to the distribution of funds for the Open Competition and the Talent Programme Veni/Vidi/Vici across its domains? What bases are known from literature or experience of other (international) councils, for example?
    a. What is the justification for each of these bases, and what objections might they raise?
    b. Which bases are practical? For example, are underlying data available, or easily made available?
2. What bases lead to an indication of the size of cross-domain research? How can NWO possibly apply them for the allocation of funds to cross-domain research in Open Competition and Talent Programme?
3. How can NWO adapt the distribution mode(s) that follow from the bases mentioned in 1. and 2. to changing circumstances in the future?

Approach
To arrive at the results we describe in this report, we delved into the information found on the websites of the various public research funders (research councils) in a number of reference countries. We held interviews with staff from foreign funders to discover how they allocate budgets across domains. We held interviews with representatives of stakeholders in the Netherlands, in which we asked for their views on the topic of budget distribution.

Delineation
This report deals with budget allocation for two instruments: the Open Competition and the Talent Programme. These two instruments are intended for free, curiosity-driven research. For thematic research and for funding scientific infrastructure, NWO has other instruments. These are beyond the scope of our study. This report is not about the extent to which NWO's programme lines match the societal needs of the Netherlands and how the Open Competition and the Talent Programme fit in. In this report, we suggest a number of possible bases for budget allocation, without making a judgement on the desirability of the different variants. However, we do indicate the limitations of different possible bases.

This report has been written on the basis of the information gathered during our orientation by analysing the available documentation and conducting interviews. It offers no more than an eclectic overview of foreign systems and of current opinions

on this topic among stakeholders in the Netherlands. It limits itself to answering the questions posed, using the information obtained as a source of inspiration.

The main question NWO has put to us is about possible bases for budget distribution. The question to us is not whether the budget distribution across domains as it is now should change and whether it should be based on a foundation. During our research, we came across a variety of views on this. We touch on these views in this report, but do not provide a balanced overview of them, let alone a unified answer to this question. We also do not answer the question of whether promoting bottom-up, curiosity-driven research is a task best invested in NWO's domains.

The additional question NWO asked us was about an indication of the extent of cross-domain research and how to use it in the allocation of funds to this type of research. We were not asked how important cross-domain research is for the development of science and society, nor whether cross-domain research proposals structurally come off less well in the current assessment and funding system and whether reserving funds for this research is therefore desirable. We also encountered divergent views on these issues in our research. We touch upon them in this report, but do not provide any empirical evidence or pass judgment on them.

1 Budget distribution

Before addressing the question on what possible bases a budget distribution for the Open Competition and the Talent Programme could be based, it is useful to reflect on the requirements that a budget distribution should ideally meet. This will clarify what a budget distribution system, whether based on a foundation or not, should achieve.

We have come across the following requirements:

- **Fairness**: a budget distribution should be perceived as fair by stakeholders. While few will dispute the importance of fairness, opinions do differ on what is fair. Is it fair if all researchers who apply for the instruments in question have an equal chance of being funded? Or does justice require first and foremost that the best proposals be funded?
- **Effectiveness –** supporting the goals of the instruments: the Open Competition and the Talent Programme are there to fund free, curiosity-driven research across the full breadth of science, in order to arrive at new, preferably ground-breaking scientific insights and thus create a breeding ground in terms of knowledge and capacity for further fundamental, thematic and applied research.

For a budget distribution to be perceived as legitimate by the field, it is necessary that it is seen as fair and effective. The field will only perceive a distribution as such if it is based on a clear and transparent argument. A quantitative basis could play a role in this.

There is disagreement among stakeholders on the above requirements, in particular on whether the current budget distribution is fair or not, and whether the distribution adequately supports the objectives of the instruments or not. A shared view of the extent to which the current budget distribution is equitable and effective would be a first step towards answering the question of whether something should be done to the distribution system, for instance by basing it on a foundation.

The debate on the distribution of resources is conducted against the background of diverging images of the future of science, and thus of the function of the Open Competition and the Talent Programme in the set of funding instruments. Some of our interlocutors see a future mainly in more cooperation in larger, often interdisciplinary programmes. This is where the Open Competition and the Talent Programme should fit in. Others believe that scientific progress is primarily served

by giving free rein to the curiosity of individual scientists and the work that this inspires. They value the Open Competition and the Talent Programme as the instruments par excellence to provide the necessary space for independent research.

Besides these requirements that a budget distribution should meet, we also came across a few factors that a distribution system could or should take into account. On these, we have come across less discussion in the field. These factors include:

- **Differences in cost of research**. Research in some disciplines, not only in most humanities, but also, for example, in mathematics, is significantly cheaper than research in other disciplines such as medical sciences. Therefore, a budget allocation could take into account: i) the average cost of a research project within a domain, or ii) the average amount requested within a domain over the past three years (in cases where that amount is not capped ex ante).
- **Alternative sources of funding**. For example, for the medical domain, unlike the other domains, funds are available from public fundraising and from the Ministry of Health, Welfare and Sport. For a number of, mostly technical, disciplines, more funds are available from contract research, including Horizon Europe, than for others. To the extent that this funds curiosity-driven research, one can let this influence the budget distribution.
- **A good balance between predictability and flexibility**. On the one hand, a budget distribution should have a certain degree of stability over the years. Too much fluctuation in the distribution of funds makes planning difficult, both for funders and potential applicants. On the other hand, insights or circumstances may change over time and a budget distribution should be able to respond to those.

If adjusting the budget distribution is desirable, it could be done by grounding the distribution on a basis. A question to ask with any possible basis is whether it can lead to a budget distribution that meets the requirements of equitability and effectiveness. To answer this question, two steps are necessary. The first is to determine whether*, in principle,* a basis leads to such a budget distribution. Then, it is to determine whether that can be the case *in practice*, given what data is and is not available and to what extent those indicators reflect what the basis would like to measure.

2 Other countries

Before looking more closely at possible bases for funding distribution, we briefly describe how science councils in other countries deal with the distribution of budgets across disciplines. In this chapter we sketch a general picture; in Annex 1 we provide additional information per country. In consultation with NWO, we looked at the situation in Sweden, Norway, Denmark, Finland, Belgium (Flanders), Germany and the UK.

2.1 The position of research councils

There are considerable differences between the research councils we looked at for this study. Some, like NWO, invest exclusively in academic research at public knowledge institutions. Others, like the Norwegian council, also fund innovation at companies. In doing so, they combine the function of NWO and RVO (the part of the Dutch ministry of economic affairs that stimulates innovation). Whereas NWO does not invest in research at national knowledge institutions and RTO institutions (public knowledge institutions for applied research), the German council does to some extent. We also see this broader target group in Norway and the UK.

In most countries, the council is not the only source of research funding. Just as in the Netherlands other ministries besides the ministry of education, culture and science (OCW) also fund scientific research (including the ministries of economic affairs, health and agriculture), this also happens in Norway, the UK, Sweden and Germany. In addition, scientists also have access to European Union programmes.

Furthermore, the organisational position differs from country to country. In some countries, a counterpart of OCW directs the council and in others, e.g. the UK, it is a ministry primarily dealing with economic affairs. Funding usually comes from the departmental budget, but is sometimes supplemented by additional resources from other departments.

The councils also differ widely in the degree of autonomy they have in spending funds. Those of Finland, Denmark and Germany are largely autonomous, similar to NWO. There are also some, for example those of the UK, Norway and Sweden, which receive clear instructions from their parent or co-funding department regarding substantive priorities. This is somewhat similar to the relationship of the

Dutch ministry of health to ZonMw. Where this is the case, the ex-ante distribution of resources across domains and topics is a given.

Box 1 **Autonomy or politics**

Different countries interpret the role of departments in relation to funders (councils) in various ways:

Setting frameworks. In this model, the department's role is limited to that of setting the budget. This is a matter of political decision-making, for which the usual budget cycles are followed. This usually leads to fairly stable or slightly increasing budgets. Decisions on spending are in the hands of the funder. This involves the division between fundamental and strategic research, between funding of individuals and of consortia, between disciplines and domains, and ultimately between the various grant applications. Usually, scientific criteria and advice from (often international panels of) peers are decisive.

Guiding on outlines. The department, and thus politics, not only determines the larger frameworks, but also determines the distribution of money across instruments (across programmes, across types of spending such as infrastructures or careers) or across domains and/or research themes. This leads to arguments such as innovation potential and competitiveness playing a role in the decision-making process, in addition to scientific criteria. The funder decides on the allocation of funds to projects.

Steering in detail. Politics plays a defining role down to the level of decision-making on projects. The council advises on the distribution of money across instruments and domains and on project funding, partly on the basis of peer review, and the ministry decides. The council mainly has an executive task and monitors the scientific quality of the research to be carried out.

2.2 The distribution and allocation of budgets

When we looked into budget distribution of other countries, we could not find a clear story about why the distribution of budgets across disciplines is as it is. On further enquiry, concerning the part of the funding that goes to fundamental research, some councils, such as the Danish and Norwegian councils, do use a formula to adjust the distribution over time. These are fairly simple keys, which take into account developments in the demand for funding (in terms of funds requested and numbers of applicants), and do not lead to large shifts in the distribution from year to year. None of our interlocutors from other countries indicated that the distribution used leads to much tension and discussion. Reportedly, distributions of budgets across domains are generally quite stable and fairly widely accepted. This may have to do with the fact that adjustments, insofar as they take place, are based on a formula. It may also have to do with the fact that the design of the system is less rigid than the Dutch system: there are more opportunities to work across domain boundaries and, for example, assess and/or fund projects together. For example, the German DFG works with four domains and, below them, 48 separate funding boards, managed by nine departments of the organisation. Thereby, the content of an application may result in its assessment and funding being spread across several funding boards.

How the distribution across disciplines works out in different countries is difficult to visualise from the available data. The division into domains varies greatly from country to country. Moreover, it is far from clear whether the available figures refer to spending in universities of resources on free, curiosity-driven research.

Procedures used by councils are similar. Reviews of proposals are all done in peer-review committees, which give advice to the final decision-makers. Especially small countries see to it that the reviewers do not come from within the country or at least some come from abroad.

In some countries, such as the UK and Norway, impact is explicitly mentioned as a criterion in funding decisions. Domains such as life sciences, medicine and technical sciences then have an advantage over more fundamental disciplines because impact is much easier to demonstrate or make plausible there. Whether this also leads to those fields actually being better off financially is not explicitly stated.

The low level of funding rates is an issue in all countries, but more of a concern in some countries than in others. Concerns about the low level of funding are significantly higher in countries such as Germany, the UK and Flanders than in

Finland, Denmark, Norway and the Netherlands. To address this, some countries, including Norway, limit the number of applicants by imposing conditions on resubmission, as does the European Commission. In doing so, individuals whose applications have been assessed as unsatisfactory cannot reapply for a period of one or two years afterwards.

Countries deal differently with the assessment of inter- and transdisciplinary research. In Denmark, Flanders and Finland, separate committees aimed at assessing interdisciplinary research exist for this purpose, in addition to the disciplinary-oriented committees. In Germany, applicants can indicate by which of the 48 disciplinary funding boards, or a combination thereof, they want to be assessed and funded.

2.3 A brief overview by country

In ***Sweden***, the VR (Vetenskapsrådet) has a limited mandate: the spending of 80% of the money is guided in terms of content and procedure by detailed annual regulations from the government. There are three scientific councils (the technical sciences and natural sciences fall under the same council) and a few committees. The budget distribution among the councils has been stable for years and it is not clear what it is based on. Because most of the money is mandated by the government, the scope of possible bases would be relatively marginal. For the part that the VR can decide, variables such as the number of applications, the number of scientific staff and the cost of research have been considered in the past, as well as how other countries address the issue. No further changes to the distribution key have resulted from that, except an adjustment of the budget for social sciences and humanities to bring the distribution more in line with those in other countries. As elsewhere, history determines the distribution.

Norway has a science council (RCN) with 16 portfolio boards. Of these, 13 are subject-focused. Three fund basic research and each serves a specific discipline group. The distribution of funds among the portfolio boards is determined by the interplay of the ministries involved. The three basic research boards are funded by the Norwegian Ministry of Education and Science. Among these three, the budget distribution was determined at one time in the past on the basis of the number of scientists in the various fields at the universities. Nowadays, three-quarters of the distribution is based on last year’s budgets and the remaining quarter on the share of applications. If a certain field receives many applications, it gets slightly more money. This system leads to gradual fluctuations each year.

The Science Council of ***Denmark*** (DFF) has six domains and one interdisciplinary domain. Again, there is a traditional ratio of budgets per domain. Small variations per year are achieved by basing the distribution 60% on the previous year's distribution, 30% on the average amount granted over the past three years and 10% on the number of applications in the last three years.

In ***Finland***, the Academy of Sciences (AKA) works with three research councils and a more finely-meshed division into discipline groups. The distribution of budgets among the councils is not predetermined. Proposers indicate within which councils they want to be assessed. Fees do not vary much per year and per research council. So there are no predetermined distributions and there is no formula for this.

In ***Flanders,*** the public research funding body (FWO) does not apply a predetermined budget distribution across its six domains (one of which is cross-disciplinary). Applicants submit proposals, indicating themselves within which domain they want to be assessed and funded. Evaluation panels use a uniform system to award points to proposals. FWO then funds the proposals with the highest scores. Over the years, this system results in very limited changes in the budgets per domain. The award chances per domain are very close to each other.[1]

Germany's science funding body (DFG) also does not assume a predetermined distribution among science fields, and thus does not use a basis for distribution. Yet that distribution is remarkably constant over the years. Again, applicants indicate within which fields and which of the 48 funding boards (or combinations thereof) they want to submit.

In the ***UK,*** the Ministry of Economic Affairs (BEIS) is the primary funder. Spending is specific in nature, as the target groups for funding are not only universities, but also public knowledge institutions and companies. A basis for distribution is actually not an issue. The government determines the budget; the councils have to demonstrate that proposals show scientific quality and will have impact. Proposals from the council (UKRI) and the Royal Academy of Science are an input for the government to determine the distribution. We have no information on how UKRI and the academy arrive at their proposals.

1 Scientific Research Fund Flanders (2023b).

3 Possible bases

In this chapter, we identify possible bases for the distribution of Open Competition and Talent Programme budgets across the four NWO domains. We found three groups of possible bases that influence the perceived fairness and/or effectiveness of budget distribution:

1. Foundations that measure current or potential demand for funding;
2. Foundations that measure the quality of research in a domain;
3. Foundations that measure the (scientific or societal) impact of research in a domain.

The sections below discuss these three groups.

3.1 Demand for funding

A basis for budget allocation could take into account the potential demand for funding from the relevant field of researchers. The idea here would be that a higher demand for funding justifies a larger share of the budget. To measure potential demand, we see the following possibilities:

- applications in previous periods;
- numbers of promotions per year in the different fields;
- the size of the scientific staff within the various fields at universities and academic hospitals;
- the extent of research output in the different domains.

In the table below, we give the figures for each of these indicators for 2022. Use of the indicator ‘applications in previous periods’ we have also encountered abroad. The impact of the use of (a combination of) the mentioned indicators becomes clear at once in the table below. ENW shows a downward trend, while ZonMw in particular shows an upward trend.

Domain	Possible indicators				Distribution in 2022		
	Previous applications	PhDs awarded	Academic staff	Research output	Open Competition	Talent line	Total both instruments
ENW	?	19%	13%	34%	46%	37%	42%
SGW	?	25%	30%	14%	23%	33%	28%
TTW	?	18%	20%	12%	20%	12%	16%
ZonMw	?	38%	37%	39%	12%	18%	14%

Sources: PhDs: CBS (2022); WP: Rathenau Institute (2023) and (2021); output research: Rathenau Institute (2022a).[2]

3.1.1 Number of applications in previous periods

This indicator refers to grant applications in one or more previous periods, in terms of numbers and/or in terms of euros.

We know of no publications or data files in which figures on the numbers of applications and requested budgets are given for the two NWO programmes separately. However, the basic material for this is expected to be available in the NWO organisation.

This indicator could be further refined by counting only those proposals that came out as qualitatively up to par in the assessment. If there are relatively few proposals in a given domain, but many of them have a good rating, this should have a positive impact on the base. Just the number of proposals or amounts requested may not say enough. By including the evaluation of proposals, the perverse incentive to just submit a large quantity of low quality applications can be partly overcome.

3.1.2 Number of PhDs awarded

The number of PhDs awarded per year is accurately known. The most commonly used figures are those from CBS, because they include healthcare PhDs, where

2 Notes:

- Figures on the number of PhDs by discipline are presented annually by CBS. CBS uses a discipline classification with ten categories. These are traced to NWO's four domains.
- The Rathenau Institute presents fact sheets on staffing at universities. That does not include medics and the primary data on them have been provided by the NFU to the Rathenau Institute for several years. In turn, both sources can be traced back to the personnel records of universities and UMCs. The data have been traced back to the classification of NWO domains.
- The data on publication output have their source in the Web of Science Database. The classification into six main areas has been traced back to the NWO domains.

those are missing from the data of Rathenau Institute and Universities of the Netherlands (UNL). CBS's classification is a different one from NWO's, but can be more or less reduced to that by redirections:

- ENW: CBS code 5 (mathematics, natural sciences) and 6 (computer science);
- SGW: CBS code 1 (education), 2 (design, arts, languages and history), 3 (journalism, behaviour and society) and 4 (law, administration, commerce and business services);
- TTW: CBS code 7 (engineering, industry and construction) and 8 (agriculture, veterinary and animal care);
- ZonMw: CBS code 9 (health and welfare).

The table above is based on figures from one specific year. To avoid excessive fluctuations, it would be better to work with a moving average over a number of years.

Looking at the numbers of PhDs, it is striking that ENW receives more than twice as much budget as would be expected based on these numbers alone, and that this is mainly at the expense of ZonMw, which receives only a little over a third of what this indicator would suggest. Looking at the Talent programmes alone, SGW has relatively more and TTW less budget to distribute.

The number of PhDs is a very rough indicator of the demand for research funding. The extent to which PhDs apply for the Talent Programme or the Open Competition differs between fields. For example, we see a relatively large proportion of the total number of PhDs in medical sciences. However, it is known that PhDs there are mostly written as a stepping stone to training as a medical specialist, rather than with a view to a research career. A high proportion of PhDs in healthcare therefore does not mean that there is a high demand for participation in NWO and ZonMw programmes.

It is also known that PhDs in engineering are much more likely to be found outside university than those in social sciences and humanities. The same is also true, but slightly less so, for those in the natural sciences.[3]

3.1.3 Size of the scientific staff

Dutch universities and UMCs employ scientists in various positions, from PhD to full professor. NWO's various instruments each target particular positions. From the

3 Koier, E. and J. de Jonge (2018).

Rathenau Institute's figures, aggregate data can be extracted of the size of the workforce per field of science. The original sources are UNL's WOPI files and the NFU (Dutch federation of academic hospitals) system. These can be converted into NWO's classification of research domains. In doing so, the Economy, Behaviour and Society, Law, Education and Language and Culture sectors have been allocated to the SGW domain, Technology and Agriculture to TTW, Nature to ENW and Health to ZonMw. The figures all refer to numbers in FTEs.

This indicator presents a similar picture to that of PhDs awarded. Largely the same remarks apply here as for the PhD indicator. For ENW it pans out somewhat more extreme: it receives more than three times the budget than would be expected based on this indicator.

One factor limiting the value of this indicator is that there is no one-to-one relationship between the background or workplace of researchers and the domain to which they apply for funding. Depending on their research proposal, for example, researchers from outside technical universities submit applications to TTW and researchers at academic hospitals submit applications to ENW or researchers at science faculties submit applications to SGW.

For this indicator, it should be noted that there is a difference between the size of scientific staff and the size of research capacity. Not everyone belonging to the academic staff has research tasks of equal size. In disciplines where student numbers have grown most rapidly while lump sum funding for research has not kept up, research appointments are more limited on average. The question is whether a base should be based on the distribution of staff numbers across domains, or on the ratio of research capacity across domains.

3.1.4 Research output

An important indicator of the volume of research production is the number of articles in scientific journals. This involves English-language, peer-reviewed journals. In the table above, we use the Rathenau Institute's figures based on data from Web of Science.[4]

We note that where the medical field gets only one-seventh of the funds from these two programmes, it produces four out of ten scientific articles. In contrast, the social sciences and humanities receive a larger share of funds relative to scientific production. The other two domains are in between.

4 Rathenau Institute (2022a).

This indicator also has its own limitations. It is important to keep in mind here that publication cultures vary for the different domains. Particularly for the SGW domain, many results here are not published as articles in English-language journals, but as articles in another language, which therefore do not appear in the Web of Science, or as books, whose writing is relatively time-consuming.

3.2 The quality of research

A basis for budget distribution could take into account the development of research quality in the different domains. The idea behind this could be that a domain should receive a larger share of the budget the higher the quality of its research: backing winners. Of course, an alternative idea could be that a successful domain actually needs less support. Citations are a common, but not necessarily a useful measure of quality. Another indicator of quality can be derived from international university rankings.

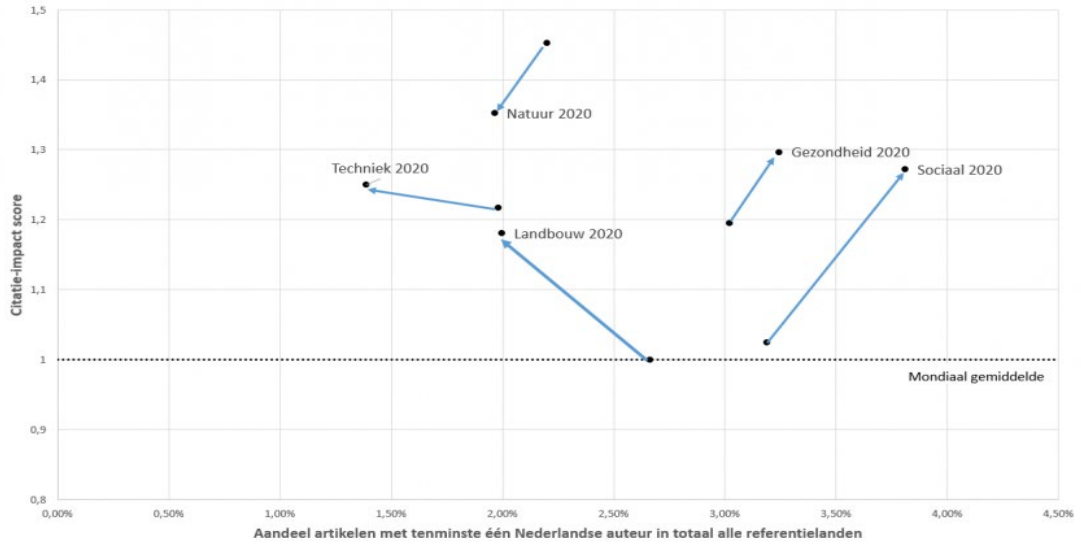
The nature of research varies widely across fields and even disciplines. In some disciplines, there is some agreement on intellectual priorities, the research agenda and the definition of quality, while in others there are competing paradigms and agendas. In some disciplines, (large-scale) collaboration is common or even necessary, while in others research is rather an individual activity. Between disciplines there are strong differences in methods, routines and cultures of research.[5] Also, publication and citation habits differ widely. All this means that comparisons of research quality between domains are not very meaningful. Nevertheless, below we pay attention to the bases for budget distribution that might make use of them.

3.2.1 Citation index

The quality of research is often described in terms of the citation index. This index indicates how often an article is cited by other authors. The global average is normalised to the value of 1. A score above 1 means that the particular article from which the index is calculated is cited more than the average and a score below 1 the reverse. It is thus a score of scientific impact. The citation index can be calculated for a single article, for a single author but also for an entire country or – and this is the point here – for a domain in a country.

5 Scholten, W., L. van Drooge and P. Diederen (2018).

Figure 1
Development of the Dutch research profile (2004-2020)



Note: In this graph, the citation impact score is plotted against the percentage of Dutch articles in the total number of articles in a science field. The arrows indicate the development from 2004 to 2020.

Source: Rathenau Institute (2022b).

Figure 1 above shows how five Dutch science fields developed between 2004 and 2020 (due to limited data in the Web of Science database, the humanities are not shown). The citation impact score has increased for all except natural sciences. Its score was a lot higher than that of the other fields at the beginning of the period; although it has decreased, it is still above the others. The Netherlands is in the top five best scoring countries in all fields, but there are differences. Because we do not have data for much of the SGW domain for this indicator, we have not translated it into a budget distribution per domain.

Citations can give an indication of research quality within a domain, but they are at best a partial and indirect indicator. They are certainly not suitable for comparing research quality across domains.

3.2.2 Rankings

An alternative could be to use university rankings. The CWTS Leiden Ranking differentiates by five domains, namely: biomedical and health sciences, life and earth sciences, mathematics and computer science, physical sciences and engineering and social sciences and humanities. These domains are not very similar to NWO's domains. The QS World University Rankings by Subject

distinguishes five domains that, when the last two are combined, are much more similar to NWO's:[6]

i) natural sciences;
ii) engineering and technology;
iii) life sciences and medicine;
iv) arts and humanities;
v) social sciences and management.

If Dutch universities rise faster in one of the domains than in other domains, this could be a reason to increase that domain's budget share, for example.

By way of illustration, the table below shows the development of the average scores of Dutch universities in the five QS domains. For this, we used the 2020 and 2023 QS data.[7]

Domains	**Average score NL universities**		
	2020	***2023***	***Difference***
Life sciences and medicine	75,7	73,3	-2,42
Natural sciences	72,9	72,6	-0,30
Arts and humanities	74,1	71,6	-2,54
Engineering and technology	72,1	70,8	-1,33
Social sciences and management	71,3	69,9	-1,38

The average scores of Dutch universities do not vary widely across the different domains. In both 2020 and 2023, life sciences and medicine scored highest and engineering and technology and social sciences and management scored second-lowest and lowest, respectively. Natural sciences and arts and humanities switched places. Between 2020 and 2023, the scores of all domains decreased, those of natural sciences the least and those of arts and humanities and life sciences and medicine the most.[8] Were a distribution base to move with the change in scores, it would be at the expense of the latter two.

6 The similarity is not exact. For example, agriculture and forestry falls under life sciences and medicine at QS, but does not fall under ZonMw in the Netherlands. Given that QS also makes available disaggregated data, this could be corrected for.

7 QS World University Rankings by Subject 2023.

8 Interestingly, the scores of the domains in the QS ranking decreased between 2020 and 2023, while the citation impact scores of some domains increased between 2004 and 2020. The QS ranking is based on a number of indicators, of which citations is one. See the QS World University Rankings by Subject 2023 website for details.

3.3 The impact of research

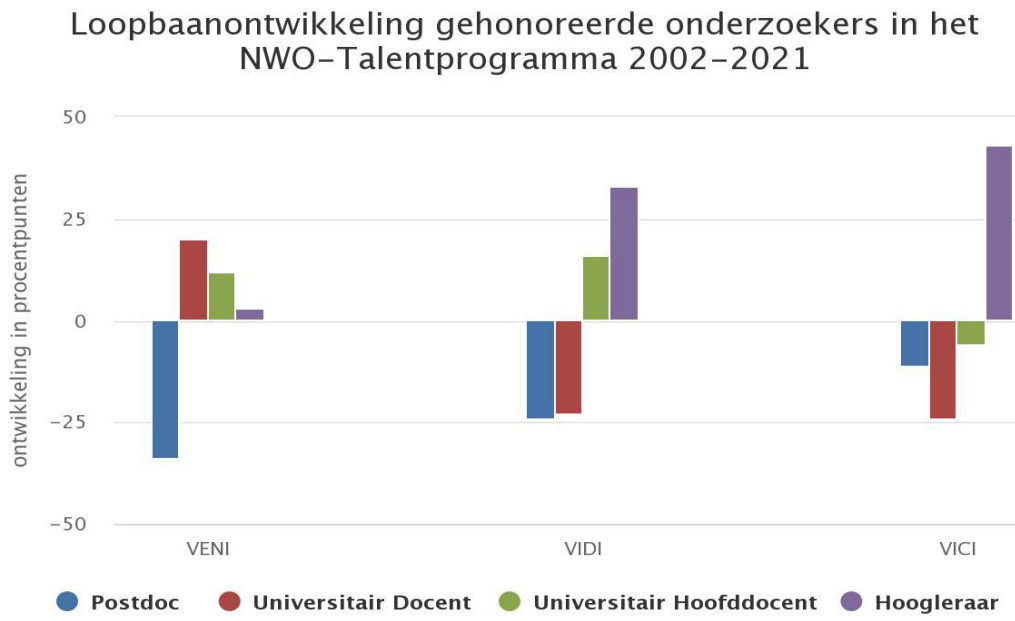
A basis for budget allocation could also be based on an indicator of the impact of research from different domains has. The idea behind this would be that a domain whose research has more impact should receive a larger share of the budget. Impact is not a property of the research itself, but is a consequence of the research. A distinction is often made between societal (including economic) and scientific impact. With the Open Competition and the Talent Programme, the main focus is on scientific impact. Societal impact is not an objective here.

When it comes to measurement, scientific impact is indistinguishable from research quality. This has already been addressed in the previous section. Societal impact of curiosity-driven research within a domain is completely impossible to measure. In general, it is impossible to establish a direct relationship between certain research and specific societal changes, because all kinds of additional factors come into play over a long period of time. A secondary impact of research, indirect but intended, is the effect of the two instruments in question on researchers' career development. This could perhaps be included in a basis for budget distribution.

3.3.1 Careers

In particular, the three components of NWO's Talent Programme are intended for separate phases of the scientific career: newly promoted, several years of experience and senior researcher. The aim here is to facilitate the next step in the career: getting a permanent appointment, going through a tenure track and developing one's own research group.

Figure 2



Career development of grant recipients of the NWO Talent Programme, 2002-2021 (in percentages): i) postdocs, ii) assistant professors, iii) associate professors, iv) full professors

Source: Rathenau Institute (2022d).

Figure 2 gives an impression of the extent to which a Talent grant actually makes that next career step attainable. It shows what happens to researchers' tenure between the award of a Veni, Vidi or Vici grant and the end of their project. Many researchers move on to a higher scientific position during their awarded project. For example, the share of postdocs among Veni laureates decreases by 34%, while the share of UDs increases by 20%. With Vidi and Vici, besides the share of postdocs, the share of UDs also decreases significantly. After being awarded a Vici, almost half of the laureates receive a chair.

If these data are available by domain, they can be used in a basis for budget allocation. But data are limited here. Due to GDPR restrictions, it is no longer possible to track individuals longitudinally, let alone identify differences between domains. With the current data, it is not possible to find out whether laureates make career moves or not. If this is to be included in a basis for budget distribution, more detailed data are needed.

3.4 Additions

To conclude this chapter, we briefly draw attention to three aspects that are important in the design of a base for budget allocation: the functional form of a base, the use of growth rates, and additional possible arguments for a base..

Functional form
A basis for budget allocation can be based on one or more of the indicators we have described above. The functional form of a basis can be made very complicated, but it can also be very simple and transparent. A good example is the distribution key used in Denmark: the share of the total budget a domain receives is equal to 60% of the budget share from the previous year; of the remaining 40%, three quarters is distributed based on the average amount applied for from the domains in the past three years, and one quarter based on the average number of applicants in the past three years from the domains:

> Budget share$_{t}$ = 60% budget share$_{t-1}$ + 30% share of total amount requested $_{t-1 \ldots t-3}$ + 10% share of total number of applicants $_{t-1 \ldots t-3}$.

This allocation key ensures stability on the one hand and, on the other, that it moves with (in this case) the demand for funding. The ratio between stability and responsiveness is easy to adjust by choosing a ratio other than 60 / 40.

Levels or relative changes
One problem with many indicators mentioned in this chapter is that they turn out very differently in different domains. Numbers of publications and citations, numbers of collaborations, qualities of project proposals, amounts requested per project proposal: all such variables have a domain-specific character because research routines differ. This means that the levels of these variables cannot be compared between domains in a meaningful way. Therefore, it is better to work with growth rates rather than level variables in a base. For example, what matters for next year's budget distribution is not so much what the numbers of citations within the different domains are, but rather how big their increase or decrease is. Given an initial budget distribution, its dynamics can be made dependent on the relative changes in the parameters to be chosen.

Incentive effect
There is an incentive associated with each budget allocation base. If the base contains a certain variable, this leads to behaviour to influence that variable in a favourable direction. In doing so, it is important to keep two things in mind. First, if the indicators in a base deviate from the purpose of the financing instrument, this leads to a perverse incentive. This is the case, for example, when an indicator of

actual or potential demand for funding is included in the base. This further fuels financing demand. *Ceteris paribus,* this leads to even lower award rates. Second, if indicators measure the purpose of the funding instrument, but do so in an imperfect or partial way, a perverse incentive also arises from this. This can happen, for instance, if quality or impact is measured by citations. Then the basis encourages researchers to focus on measured quality (more citations, higher rankings), and not necessarily on desired quality. How strong this incentive effect is cannot be said.

Perverse incentives also lead to loss of efficiency. A budget distribution key based on the level of demand for resources provokes more demand. This may involve both more proposals being submitted and proposals asking for more resources. If more proposals are submitted, it leads to more costly evaluation procedures and to more rejections of proposals that are good but still cannot be honoured. This is at the expense of the efficiency of the grant instruments.

Whereas a budget distribution based on a formula can lead to perverse incentives, a stable budget distribution determined on historical grounds leads to self-reinforcing effects. For example, if the historical distribution proportionally funds a specific domain generously, this leads to capacity growth in this domain, thereby increasing demand for resources and perpetuating the original imbalance.

4 Cross-domain research

Following the main question on possible bases for budget allocation, NWO asked us a secondary question: 'What bases lead to an **indication of the size** of cross-domain research? How can NWO possibly apply these for the allocation of funds to cross-domain research in Open Competition and Talent Programme?'

Virtually all our respondents in this survey endorse the importance of cross-domain research. A number of them expect scientific progress at the interfaces of disciplines, not only in applied research, but also in basic research. Therefore, they feel it is important that there is sufficient room for cross-domain research proposals, also within programmes for curiosity-driven research such as the Open Competition and the Talent Programme. They fear that within the existing structure, there are too few opportunities for cross-domain research.

4.1 The scope of cross-domain research

To determine the scope of cross-domain research within the Open Competition and the Talent Programme, first of all, a characterisation and delineation of cross-domain research is needed. To qualify as cross-domain research requires more than researchers from different domains being involved. Cross-domain research is a form of interdisciplinary research. For a further characterisation of interdisciplinary research, please refer to *Knowledge Platform for Inter- and Transdisciplinary Research* established by NWO for this purpose and to the system used by the Flemish Research Council FWO to distinguish interdisciplinary research proposals.

The simplest way to determine the extent of cross-domain research is then to categorise and count submitted and awarded research proposals in terms of numbers and requested budgets. This allows the shares of requested and allocated funding to be calculated.

Other variables could also be used, analogous to those mentioned in the previous chapter, such as the extent of cross-domain research output, the number of references to cross-domain research, or the number of career moves to a research position of a cross-domain nature. If such indicators say anything at all about the extent of cross-domain research, they do so in a very indirect way. Moreover, due to small numbers and data limitations, using these variables seems impractical.

4.2 Cross-domain research in other countries

What is considered cross-domain research in different countries depends on the division into domains. This varies somewhat between countries. A proposal that is cross-domain in the Netherlands because it belongs to both TTW and ENW is not seen as being cross-domain in Sweden, for example, because there it falls under the domain ‘nature and technology’. This makes it difficult to compare numbers of cross-domain proposals across countries.

Moreover, the distinction between domain-specific and cross-domain research is inappropriate in many countries. In many councils, a significant part of their spending is already driven by theme-oriented decisions by central government, for example in Sweden, Norway and the UK.

There are three ways for a research funder to deal with research that belongs to multiple domains:

- Establish a separate facility for applications for cross-domain research, in addition to facilities for individual domains.
- Do not set up a separate facility, but make it as easy as possible to fund research from the budgets of different domains.
- Fund research along thematic lines, focusing on a specific topic and thus potentially cross-domain.

Sweden does not have a separate facility for cross-domain research, but has created framework conditions to enable interdisciplinary research. In the statistics, cross-domain research does not appear as a separate category. There is relatively large scope for thematic research and the lion’s share of the budget is spent on that.

In ***Norway,*** research money is distributed through 16 councils. Thirteen of these are strategic in nature and not disciplinary. Together, they spend 90% of the research budget (at universities, research institutes and companies). Multidisciplinarity is ingrained in these councils. There are three disciplinary councils (natural sciences and engineering, life sciences, humanities and social sciences) that together spend the remaining 10%. Among these three, there is no separate facility for cross-domain grant applications.

Denmark’s research funding body DFF has five councils (natural sciences, medical sciences, engineering, social sciences and humanities) and a cross-council committee. This committee consists of the chairs of the five councils. It coordinates the handling of cross-domain proposals. Researchers wishing to submit a proposal

to more than one domain submit it to the committee, which then decides which procedure the application will go through. Councils can also submit a proposal to the committee if they believe it partly belongs in another domain. For genuinely cross-domain proposals, DFF has set aside a sum of money.

In ***Finland***, the council distinguishes over 60 disciplines, divided into seven discipline groups that fall into three domains. There is no specific focus on nor reporting of cross-domain research.

Flanders distinguishes between fundamental research and strategic basic research. Within basic research, there are 30 expert panels and one interdisciplinary panel where grant applications are assessed. The number of researchers with an interdisciplinary application is limited: 3% of pre-PhD applicants and 4% of postdoc applicants.

In ***Germany***, DFG does not have a separate counter for interdisciplinary research. However, it does optimise the conditions to enable interdisciplinary research. There are 48 separate councils, all of which have a disciplinary composition. Applicants decide themselves by which council or combination of councils they want to be assessed. This also leads to cross-border proposals being funded by different councils. Statistical information on what proportion of spending is on cross-council research (in money or number of applications) is not available.

In the ***UK,*** six research councils invest in research within as many disciplinary domains and three councils invest in innovation, knowledge transfer and research facilities. There is no separate counter for cross-domain research. However, some projects are not assigned to one of the research councils but are submitted directly to the UKRI umbrella organisation. Of these, no disciplinary origin is noted, nor is it known whether they are interdisciplinary proposals and projects. At the time of writing, UKRI is, however, in the process of putting together an interdisciplinary assessment college.

4.3 What to do with cross-domain research

In principle, it is possible to allocate a budget for cross-domain research and open a separate desk for it. This might be appropriate if cross-domain proposals within the current assessment system are at a structural disadvantage compared to proposals that fall within a single domain. This is the case, for example, when assessment committees within domains are not well placed to appreciate the qualities of cross-domain proposals.

A separate facility and review process also has challenges. For instance, there are numerous ways in which different disciplines can interact in a cross-domain proposal. This complicates putting together good assessment committees.

An alternative is to create more opportunities for cross-domain proposals within NWO's current organisational structure. We see the following options (some inspired by practices in several other countries – for details, see the description in Annex 1):

- Adjust rules to make crossovers between domains easier (compare Germany). This may involve submission of a grant application to more than one domain. It may also involve submission to a domain other than the applicant's own discipline (e.g. an application from the medical field to ENW – after all, many new developments in medicine have their origins in physics).
- Harmonise the procedures of the Open Competition across domains, issue calls for proposals centrally and/or appoint assessment panels centrally, instead of each domain board separately (compare Finland, Germany, Norway, Flanders). When domains function less as parallel organisations organising everything in their own way, and when more activities are arranged centrally and along the same lines, crossovers may be easier to accommodate. Continuously opening up schemes rather than issuing calls with specific closing dates may help here.
- Ensure that whether a proposal fits within a specific domain is not an assessment criterion in the review process. Decouple the review process from the question of which budget the funding should come from.
- Allow submission and funding of proposals by two domains, especially where domains overlap (compare Norway, Germany).
- Allow proposers to indicate by which review panel, or where desirable by which panels, they would like their application to be reviewed (compare Germany, Finland and Flanders). If applicants have a say in where they are assessed, they can ensure that all relevant disciplines are involved in an assessment process.
- Offer proposers the opportunity to have a proposal evaluated as a cross-domain proposal. In that case, it is not only evaluated against the usual (substantive and other) criteria, but additionally against specific evaluation criteria for this type of proposal. This results in a score, which is weighted in the overall judgement of the proposal (compare Flanders).

5 In conclusion

5.1 Results

We took stock of which bases for budget distribution are conceivable and practical. Looking at the evidence, the following picture emerges. Three groups of bases are conceivable:

- **Bases for funding based on variables reflecting demand for funding**

  On the one hand, there are variables that measure demand quite directly: numbers of proposals submitted or amounts requested per domain in the recent past. On the other hand, there are indirect variables: promotions, academic staff and research output per domain. Variables that measure the demand for funding directly give a purer picture of the demand for funding than indirect variables. A reason for using indirect variables nevertheless could be that there is a perverse incentive from using direct indicators. Ex ante, however, it is impossible to say how powerful this incentive is.

- **Bases for funding based on variables measuring the quality of research in a domain**

  Research quality is difficult to measure and certainly not easy to compare between domains. The available variables (citations and rankings) measure quality of research in a domain in a very specific, indirect and incomplete way. There is something to be said for allowing research quality within domains to play a role in budget allocation across domains. However, the practical constraints for doing so are insurmountable.

- **Bases for funding based on variables measuring the impact of research in a domain**

  Not only the quality, but also the impact of research in a domain is not easy to measure and compare across domains. After all, this is free, curiosity-driven research. Scientific impact almost corresponds to quality of research: as mentioned, it is not easy to measure. The full direct impact of free, curiosity-driven research in a domain (scientific, economic and societal) is even less traceable. Of the indirect impact, on career developments, for example, no reliable measurements can be made.

In short, of all the possible variables that could be used as ingredients in a formula for budget allocation, only the direct or indirect measurement of demand for funding remain as practicable options. Furthermore, when looking at research funding

aborad, we have also not come across formulas for budget allocation that use other variables – to the extent that such formulas are used there at all.

In addition to this, in the first chapter we mentioned three more aspects to consider when allocating budgets across domains:

- **Differences in research costs**: average research costs vary across disciplines. What the ratio is of the costs of research from different domains can be seen from the amounts requested per research proposal in recent years. To what extent the budget distribution across domains should compensate for differences in research costs is a choice. The question is whether and to what extent research costs should be an argument in the selection of research to be funded in the Open Competition and the Talent Programme. If costs are not an argument, then one can measure the direct demand for funding mentioned above in terms of numbers of proposals submitted. If cost is an argument, then one can measure the demand for funding in terms of amounts requested. There are also intermediate routes (compare Denmark).
- **Alternative sources of funding**: besides the funding by research councils, there is research funding from contract research, from public fund raising and from lump sum financing by government. Most funds from the latter sources are not intended for free, curiosity-driven research. When it comes to the distribution of budgets for the Open Competition and the Talent Programme, funds from the first pillar (*Excellent science*) of *Horizon Europe* (ERC and possibly MSCA) could be taken into account.
- **Predictability and flexibility**: on the one hand, a certain stability of budget distribution is important, but on the other hand, the ability to adapt to changing circumstances is also of importance. The simplest way to navigate this issue – which we have also found abroad – is to split the total budget into two parts, dividing one part based on the historical distribution key and the other on the basis of a formula.

Regarding the size of cross-domain research, we found that a good way of measuring the demand for funding for this type of research is by identifying which submitted proposals meet criteria for this type of research. In principle, a share of the total budget for cross-domain research could be determined on this basis. However, we also concluded that setting up a separate facility for this research does not solve any problems with the assessment of these proposals, and that there are several procedural possibilities to better accommodate cross-domain research.

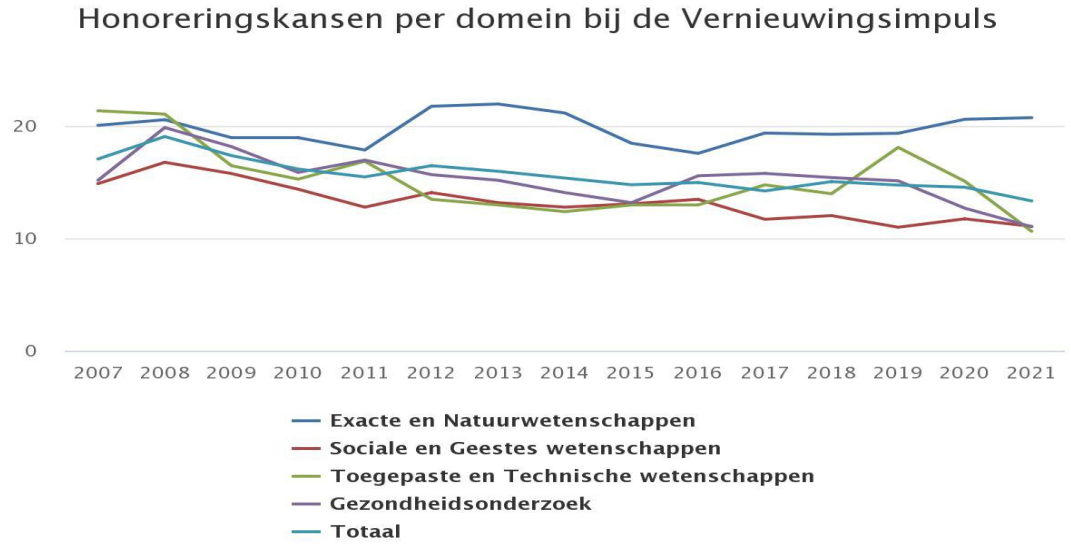
5.2 How to proceed

The ultimate question at stake is how to arrive at a budget distribution across domains that is equitable and effective. Foundations for budget distribution cannot answer that question by themselves. For that, it is necessary to first determine what constitutes equitable and effective distribution.

Equitability

The main reason for questioning the fairness of the current budget distribution is the disparity of award rates between domains. The ratio of budget demand to budget availability varies considerably. While the Talent Programme funded 21% of proposals at ENW in 2021, in the other domains it was 11% (see Figure 3). We have no such figure for the Open Competition: whereas the domains execute the Talent Programme along similar lines, in the Open Competition they each do so in their own way.

Figure 3



Award rates per domain in the Talent Programme: i) ENW, ii) SGW, iii) TTW, iv) ZonMw, v) Total

Source: Rathenau Institute (2022f).[9]

If the intention of the Open Competition and the Talent Programme is to encourage free, curiosity-driven research, one could argue that it should not matter for the success rate whether the research proposal comes from one domain or the other. Equal chances of honouring proposals of similar quality would be fair. But do

9 For the years 2007 to 2015, the data come from a file provided by NWO. In 2016 and 2017, the data come from a printout of NWO's project database. From 2018 onwards, the data are from the NWO website.

unequal award rates indicate structural injustice? Or is something else going on. For example:

- The design of instruments varies by domain. Some domains operate grant rounds with periodic deadlines for proposal submission, while others work with continuous submission. This leads to different dynamics. Deadlines lead to more submissions, also of unsatisfactory proposals, as we heard from the German DFG and from ENW, which has experience with both procedures. Continuous submission encourages perfecting a proposal before submitting it (compare also Germany). Deadlines therefore lead to more proposals per year and lower award rates. The differences in the implementation of instruments makes the award percentages in Figure 3 difficult to compare.
- The working conditions for researchers differ between domains. In one domain, scientific staff have much more research time available in their appointment than in another. For example, employees within the SGW domain have, on average, more teaching duties than their colleagues within the ENW domain. This has several effects. On the one hand, researchers with less research time have less time to develop good research proposals. On the other hand, they have a greater incentive to develop research proposals: external funding for research is the only path to a university career for them. This also makes the number of submissions across domains difficult to compare. Possibly, it is not so much a lower available budget as a stronger application incentive and thus a structurally higher number of submissions (especially if you measure it not per researcher, but per research FTE) that explains lower award rates.
- The management of proposal submission varies between domains. Besides institutions and research groups that tightly direct and dose grant applications, there are also those that leave submission to the individual researcher or reward periodic proposal submission. Such differences in application strategy can lead to different numbers of applications across the four domains.

These three points show that award rates cannot simply be compared across domains. Differences in outcomes may be caused by budget availability (the numerator) and application volumes (the denominator), as determined in part by procedure, circumstances, and management.

Effectiveness

Besides questioning equitability, comments can be made on the effectiveness of the current allocation of resources. Resource allocation is effective if it contributes to achieving the instruments' goal. The Open Competition and the Talent Programme promote free, curiosity-driven research across the full breadth of science. At NWO, they are the main instruments for funding research and research capacity development at the fundamental end of the research spectrum. There is no

thematic guidance regarding the proposals to be submitted to it. An issue is whether this remains desirable:

- More attention could be paid to the balance in the research chain, between investment in the more foundational research and the more application-oriented research. Today's curiosity-driven research provides the basis for the application-oriented research of the future.
- More attention could be paid to societal needs. The government highly values strategic autonomy, the business community likes to see key technologies developed and society considers health in particular very important (see the Dutch national science agenda NWA). At the moment, what proposals are submitted is determined by the universities' hiring policies, which in turn largely depend on the demand for academic education and thus on the study choices of high school graduates. The question is whether this is optimal.

With regard to effectiveness, it is also worth noting that a significant part of the available resources (from research council funds and from the lump sum) are not spent on conducting research or writing scientific articles, but on writing and evaluating proposals that are never funded and implemented.[10] Thus, many resources are not spent effectively.

A complicating factor in determining whether budget allocation is effective is that the domains are very different in nature. The ENW and the SGW domains comprise the basic science disciplines. At heart, the TTW domain and the ZonMw domain focus much more on applied research. The different character of TTW and ZonMw is reflected, among other things, in a different interpretation of the Open Competition. TTW and ZonMw have substantial content overlap with the ENW domain and with each other (and to a lesser extent with the SGW domain). This leads to researchers from different constituencies submitting research proposals not only to their 'own' domain, but also to the others. It is more complicated to distribute a budget effectively (and equitably) across four disparate domains than across four units that are of a similar character.

Intervention options

Taking steps to improve on the system of budget allocation for the Open Competition and the Talent Programme starts with developing a shared view with regard to equitability and effectiveness. Only then can we determine whether a basis for budget distribution makes sense and what it might look like. The options are limited.

In addition, there are other intervention options worth considering in this context:

10 Arensbergen, P. van, L.K. Hessels and B. van der Meulen (2013). See pp. 47-48, where it is calculated that about a quarter of the Veni grant funds are spent on writing and selecting proposals.

- Harmonise procedures. Do not work in one domain with periodic deadlines and in the other with continuous submission of proposals. Of course, with continuous submission, it is important to have sufficient budget to get through most of the fiscal year, otherwise the incentive to submit too early remains.
- Limit opportunities to resubmit proposals (compare European Commission). For example, set terms within which a revised proposal may not be resubmitted.
- Promote more coordination among submitting disciplines. Uncoordinated submission leads to inefficiency, duplication and a lot of extra work.
- To the extent it still happens: discourage universities from making the submission of proposals or the acquisition of grants in the Open Competition or the Talent Programme a part of their human resources policy.
- Develop a system for finding qualified reviewers of cross-domain proposals.

On a different tack

A further possibility to solve the problem of budget distribution across domains for the Open Competition and/or the Talent Programme would be to not distribute the available budget ex ante, but to make the distribution dependent on actual submissions. Add up per domain the amounts requested – after filtering out the proposals that do not meet the (formal or minimum quality) conditions – and take the ratio between these numbers as the distribution key across the domains (this is how it works in NWO's Rubicon instrument). While this system has a considerable incentive effect that may need to be addressed, it is the same for all domains.

An even more far-reaching possibility would be to place the Open Competition and the Talent Programme outside the scope of domains. This could be done by working entirely bottom-up. That it is possible to allocate funds for individual research projects on the basis of competition, without predetermining in which domain those funds should end up, is shown by the practice in Flanders and at the ERC. One option would be to gather research proposals once or twice a year in a central round and then channel them to a review panel for assessment. Several dozens of these are necessary (Flanders has 32, Germany 48).

The applicants choose the review panel. If necessary, they request an additional assessment by an expert with a disciplinary background not represented on the panel. In Finland, where applicants can also choose their assessment panel, there is the possibility of requesting the opinion of more than one panel. In Norway, panels coordinate on their own initiative. Panels score proposals according to a uniform system of criteria. The NWO Board then decides to honour the proposals with the highest scores.

Annex 1: research councils in other countries

In this appendix, we provide additional information on the system of budget allocation in a number of other European countries. We note a number of facts that caught our eye and may be relevant in the light of the research questions we answer in this report. Appendix 3 lists for each country the main written sources we consulted.

In the main text, experiences of other countries have already been presented insofar as they are directly relevant to the questions at hand. In general, these countries all have a de facto fairly stable distribution of resources over the years. But nowhere is the basis for this explicitly mentioned. History seems to be the most important determinant of distribution in these countries, as it is in the Netherlands.

Remarkably, award rates vary widely between countries. In Germany and Flanders, at 25-35%, they are much higher than in the Netherlands, Finland and Denmark, where they are around 10-15%. We did not find a clear explanation for this, but procedural arrangements such as working with continuous submission or calls may play a role in this.

Box 2 **Award rates**

NWO aims for proposal award chances of around 25%. Currently, these are significantly lower. The view that the distribution of the budget across domains is unfair is fuelled by the fact that award rates vary widely across domains. In some domains they are around 11 or 12%, while in others they are double. What about award rates in reference countries and the differences across domains?

Comparison is difficult because procedures differ. Some countries, such as Germany, operate a system of continuous submissions, while others work with one or a few rounds per year. According to DFG, this leads to researchers submitting a proposal only when they are very convinced of its quality. This would lead to fewer proposals being submitted per year, of higher quality on average. This experience is in line with what we were told from ENW, where they also have experience with both systems.

In practice, the management of proposal submission appears to vary from university to university and between discipline groups. In some places, the initiative to submit is left entirely to the individual researcher and their career prospects depend on it. This leads to many proposals. In other places, proposals are first pre-selected in order to increase the chance of success and ensure the research fits in with the traditions and spearheads of the institution or capacity group. This tends to limit the number of proposals.

Sometimes award rates are determined administratively: a predetermined percentage of proposals are awarded until the budget is exhausted. Then the scheme is closed until new budget is available. In our international comparison, it was not possible to find out all the backgrounds of the award chances. This makes comparison difficult.

Sweden: we do not have a clear picture of award rates for this country. Neither on average nor for the individual domains.

Norway: award rates there are low, averaging 13.9% in 2021.[11] The differences between disciplines are relatively limited: humanities 12.9%, natural sciences 13.3%, social sciences 16.3%, technology 11.5%, life

sciences 11.5%, agricultural sciences 21.1%. The aim is to achieve a minimum 25% pass rate through various measures.

Denmark: the success rate of proposals has decreased over the years from 18% in 2012 to 13% in the last 2 years. No specifications for discipline groups are known to us.

Finland: here, too, the success rate for submitted proposals is quite low at 14% on average. Differences between discipline groups are limited: natural sciences 14%, engineering 14%, biological sciences 17%, agricultural sciences 17%, life sciences 16%, social sciences 13%, humanities 13%.

Flanders: according to the 2021 annual report, award rates for the different science fields barely diverge. They are around 28%. If we differentiate between junior and senior researchers, between fundamental and strategic research and between projects and mandates, we see more differences, but they are not very large. Flanders aims for a 33% success rate for both projects and mandates (individual grants).

Germany: the success rate for submitted proposals in Germany at the DFG averages 28% and is fairly constant over the years. Between domains, the differences are minimal: they range between 25 and 30%.

UK: the award rate averages 23%. The odds range from 17% for natural environment, 19% for medical, 26% for humanities, 28% for biotechnology, 33% for social sciences and 37% for science and engineering.

Sweden: VR

Sweden's Vetenskapsrådet (science council, VR) invests almost eight billion kronor (about 720 million euros) in research every year. The VR's website has a handy interactive page to get a picture of the investments: Swecris – search for Swedish research projects.[12]

11 Dates have been published in https://www.forskningsradet.no/siteassets/publikasjoner/2022/forskingsradets-arsrapport-2021_2.pdf Page 22

12 Swecris (2013).

Besides four committees dealing with research in specific subject areas (education studies, development studies, clinical research and research in the arts), the VR has four scientific councils that advise on grants in their respective fields:

- The Scientific Council for Humanities and Social Sciences;
- The Scientific Council for Medicine and Health;
- The Scientific Council for Natural and Engineering Sciences;
- The Council for Research Infrastructures.

Every year, the Ministry of Education and Research mandates the VR to initiate projects within certain frameworks. Since 2008, VR funding has included a sum of just over two billion kroner (about €172 million) earmarked for the four councils. The size of the amount and distribution among the councils has been more or less stable since then. In addition, the government provides an amount to spend in specific research directions or on certain research programmes. This amount has grown, however. Whereas this earmarked budget was still considerably smaller than the budget for the councils in 2008, it is now more than twice as large. The VR receives an annual assignment letter regarding the spending of this budget. The implementation of the policy, the actual spending of the earmarked amounts, is the responsibility of the councils. This gives the ministry an important voice in the decisions on which directions the VR invests in. That makes the question of the distribution of a budget across domains much less of an issue here.

The research councils issue calls for proposals and set up review panels to assess grant applications. The council for humanities and social sciences has 10 panels, that for natural and engineering sciences 19 and that for medicine and health 20. The panels advise and the councils make the decisions.

The VR still has some leeway for decision making, but it is limited. A few years ago, for instance, it was decided to slightly increase the budget for the council for humanities and social sciences, partly as a result of a comparison with the distribution of funds in other countries. The VR has also looked at the differences in research costs between universities with different disciplinary profiles and slightly adjusted the budget distribution as a result.

For interdisciplinary projects, the VR does not have a separate council. However, applicants can request review from two different councils if their proposal falls within both domains. There is also a call for larger interdisciplinary projects. Here, decisions are not taken by individual councils, but by the central board. In addition, the VR has centre of excellence grants to which several institutions and several disciplines can jointly apply on a theme of their choice.

Norway: RCN

The Norwegian Forskningsrådet (Research Council of Norway, RCN) funds not only basic research, but also strategic and applied research and innovation. The council's activities are organised around 16 portfolio boards with 10-12 members each. Where the boards' themes overlap, calls and investments are coordinated among them. In assessing grant applications, the boards receive advice from review committees. These are the themes of the boards:

Democracy, administration and renewal	Energy, transport and low emissions	Global development and international relations
Oceans	Health	Humanities and social sciences *
Industry and services	Climate and polar research	Land-based food, the environment and bioresources
Life sciences *	Enabling technologies	Natural sciences and technology *
Petroleum	Education and competence	Welfare, culture and society
Sámi		

Three of these boards, marked with an asterisk, are for basic research: humanities and social sciences, life sciences and natural sciences and technology. The total budget for all boards combined is 12.6 billion kroner (just over €1 billion). Of this, about 10% is for basic research, funded by the Ministry of Education and Science, and to be shared by the three aforementioned boards. The rest of the funding comes from the specialist departments and is strategic in nature. For instance, the energy, transport and low emissions board alone has almost as much budget as the three basic research boards combined. The portfolios for strategic research and innovation are thematic in nature and are much less disciplinary.

RCN advises on the allocation of money between themes, but ultimately it depends on ministerial budgets. Sometimes the departmental choices match the council's advice, but this is not always the case. Moreover, some departments' substantive directions are much more detailed than others. Besides the 16 boards, there are also provisions for infrastructure and centres of excellence, as in Sweden. The RCN wants to achieve a reduction in the number of boards. The budget distribution among the three boards that fund basic research (and which can best be compared to the two NWO programmes this study is about) is three-quarters based on the previous year's distribution. At the start of the system, the distribution was determined based on the number of scientists in the relevant area at universities. The remaining quarter is determined by a given area's share of applications. This leads to gradual fluctuations in the distribution from year to year. Now the

distribution is about 40 per cent for life sciences and 30 per cent for each of the other two. There is not much discussion about that.

Award rates vary between instruments and boards and range from 7% to almost 35%. In the case of the three basic research boards, the Ministry of Education and Science wants to move towards an average of 25%. To this end, it is trying to reduce the number of applications, for example by introducing a ‘quarantine policy’: applicants with a low assessment are not allowed to submit an application for several years, following the example of the ERC. RCN is also moving from a regime where applications can be submitted once a year to a system of continuous submission, where evaluation starts as soon as a certain number of proposals is received.

Denmark: DFF

The Independent Research Fund Denmark (DFF) has five research councils, for humanities, natural sciences, medical sciences, social sciences and technology and production sciences. The councils fund research activities based on researchers’ own initiatives. There is also a cross-council committee for interdisciplinary research initiatives.

The distribution of the available budget among the councils is based 60% on last year’s budget, 30% on the average amount granted over the past three years and 10% on the number of applications in the past three years. This is mainly based on historical ratios and allows for minor variations due to differences in developments in research costs and the number of applications.

Finland: AKA

The Finnish Academy of Sciences (Suomen Akatemia, AKA) has three research councils: for Biosciences, Health and the Environment, for Culture and Society and for Natural Sciences and Engineering. In addition to the three domain-specific research councils, there is a separate council for strategic research. This covers all domains and disciplines and has its own programme and budget.

The distribution of funding among research councils is fairly stable over the years, but may change slightly: i) to take into account domain-specific developments in the cost of research, and ii) to ensure that the award rates of applicants from different research areas are more or less equal. In 2022, for example, these are between 13 and 17% for postdoc projects (similar to the Veni).

There are no calls for proposals from each of the research councils individually. The main calls are centrally organised twice a year by the Academy of Finland, not by the councils. The calls are open in nature and do not specify research topics. What

counts for whether or not they receive funding is the scientific quality of the proposal. Nevertheless, a council can invite research proposals on a specific theme. For example, in 2022, the Council for Natural Sciences and Engineering indicated that chemical research with a specific interest for Finland, e.g. on biomass processing from wood, needs strengthening.

The Academy also organises the assessment panels. These give advice to the three councils. These then take decisions on funding the applications that fall within their remit, taking into account the advice of the panels. For funding, they use the budget allocated to them.

As in Flanders (see below), it is up to the applicants to choose which assessment panel gives advice on their application. That is, after the reform of the assessment system currently being implemented.

There are (or will be) review panels covering a wide range of disciplines. Applicants with proposals that fall within the domains of different councils can therefore opt for such a broad panel. After consideration by a panel, their application is then forwarded to one of the three councils, which then decides on funding. Councils do not jointly fund proposals that cover more than one domain.

Belgium (Flanders): FWO

The Flemish Fund for Scientific Research (FWO) funds fundamental and strategic research through various channels. Most of these operate strictly bottom-up: there are no disciplinary or thematic restrictions that applicants have to meet. Scientific excellence is the decisive selection criterion. There is no ex ante distribution of the budget across domains. An important channel is that for ‘Junior and Senior Research Projects’. This funds research projects initiated by researchers and has similarities with the Open Competition.

The call for proposals for these research projects in 2023 opened at the beginning of the year and closed in early April. Evaluation and selection of proposals will take place during the rest of the year and the decision will be made in December, allowing successful proposals to start in early 2024. For the evaluation, 32 panels have been set up with basically 12 (sometimes more) members, more than half of them non-Flemish. Of the 32 panels, 31 deal with a particular disciplinary theme within one of five domains (biological sciences, medical sciences, humanities, social sciences and natural sciences and technology) and one is for interdisciplinary, cross-domain proposals. Evaluation is done in two steps. The first step is a remote assessment by two external reviewers and two panellists, followed by a rebuttal by the applicant and a synthesis of the latter and the four evaluations

by a rapporteur. The second step is an assessment by the panel in a meeting, assigning a score and determining a ranking of proposals.

What is important in this system is that the applicant chooses the panel to be asked to assess a proposal. There is the option of indicating that the project is multidisciplinary and, in that case, requesting an additional external assessment by a reviewer with expertise not represented within the relevant discipline-specific panel. Explicit requirements are imposed on proposals for the interdisciplinary panel, for example on the relationship between the disciplines and the nature of the synergy.

Assessment is done using a set of explicit criteria related to the research team and to the research project. The scores for the project determine three quarters of the proposal's final score and those for the characteristics of the team count for one quarter. For interdisciplinary projects, the project counts for 55% and the score for interdisciplinarity for 20% (and here also the team for 25%).

Because applicants themselves choose which panel evaluates an application and the panels all use the same system to score and rank applications, the distribution of funds across domains occurs in a bottom-up manner. The panels do not deal with a specific ex ante determined share of the budget. Ultimately, FWO funds the proposals that received the highest score. Implicitly, proposals from all disciplines and domains are balanced against each other in this way.

Germany: DFG

The Deutsche Forschungsgemeinschaft (DFG) funds research with a budget provided by the Federal Government and the 16 Länder. The German research infrastructure consists of universities plus a number of large, renowned non-university research organisations: the Max-Planck-Gesellschaft, the Helmholtz-Gemeinschaft, the Leibniz-Gemeinschaft and the Fraunhofer-Gesellschaft. Whereas in most countries non-university research institutes carry out at most 10% of academic research, in Germany it is almost half. The DFG mainly funds universities.

The DFG distributes EUR 2.7 billion in research funds to universities. That is about a third of the total flow of competitive funding in Germany. Of the total amount, DFG spends just under half on programmes aimed at individual researchers. The DFG distinguishes between four areas:

i) Humanities and social sciences,
ii) Life sciences,
iii) Natural sciences,
iv) Engineering sciences.

Among them are 48 review boards, which in turn are managed and directed by nine departments of the DFG's bureau organisation.[13] These 48 boards were created to review the 20.000 to 30.000 proposals DFG receives per year for funds from these individual-focused programmes. Every four years, members of the review boards are elected from the relevant scientific community. The preliminary work for the review boards is done in a peer review process that involves some 15.000 researchers per year. Formally, the role of the review board is to give advice and the DFG's central board to take decisions, but in practice the board rarely deviates from the advices.

The distribution of money among discipline groups appears to be quite stable over the years. The procedures used have been the same for years and are hardly ever challenged; decisions are hardly ever challenged. Flexibility and responsiveness have been injected into the system as the review boards work together. For example, they can combine money from their budgets to jointly fund grants covering multiple research topics. They can also publish calls for proposals together. They also set aside a small percentage of the budget for flexibility, e.g. for unusually large proposals that are expensive but nevertheless considered important, or for interdisciplinary proposals. When interdisciplinary proposals come in, they are assessed and, if granted, funded by different review boards.

The distribution of the budget among the 48 boards is done using a fairly simple formula. Half of the budget is determined on the share of the respective board in the previous year. The other half is determined by the budget share of proposals in the previous three years. As the award rate averages 28%, is fairly constant over the years and also varies little between the domains, the shares of the individual review boards do not vary much either.

A proposal for one of the individual programmes (*Einzelvorderungen*) can be submitted throughout the year: it does not go in periodic rounds. There are four to six times a year when review boards decide on proposals. A more open procedure can help reduce the number of submissions: when there are no deadlines, fewer proposals will be submitted that are still incomplete. There are no restrictions on resubmission of proposals that have been rejected and subsequently modified.

DFG does not expect many changes to the system. Working with output parameters in budget distribution would be nice. But that generates so much discussion that it is not expected to be introduced anytime soon.

13 Deutsche Forschungsgemeinschaft (2021).

United Kingdom: UKRI

The UK science council United Kingdom Research and Innovation (UKRI) is now part of the Department for Science, Innovation and Technology. Until recently, the council was part of the Department for Business, Innovation and Skills (BEIS, the Department for Economic Affairs). UKRI not only funds research at universities, but also subsidises R&D at companies (thus combining the tasks of NWO, ZonMw and RVO). UKRI invests in research and innovation and in equipment and infrastructure.

Periodically, UKRI develops a budget proposal as part of the Spending Review. On that, the ministry allocates funding, including a distribution of the budget across the nine councils and a number of strategic programmes. So ultimately, the ministry decides on the budget allocation. It looks not only at scientific excellence, but also at expected impact. How exactly the distribution is arrived at in the interaction between UKRI and the ministry is qualified as opaque. Within the frameworks set by the ministry, the nine councils each put out their calls and make decisions on individual grant applications.

Of the nine councils, six fund research in specific scientific fields. The table below shows the distribution of applications among the councils and the budget allocation.[14]

		applications	applications accepted	amount requested	amount honoured
Humanities	AHRC	14%	14%	6%	6%
Life Sciences	BBSRC	14%	15%	14%	14%
Exact wts. and engineering	EPSRC	25%	34%	33%	44%
Social sciences	ESRC	13%	13%	8%	9%
Medical sciences	MRC	20%	13%	26%	18%
Natural environment	NERC	14%	11%	13%	8%
		100%	100%	100%	100%

14 Calculated from fee data, available via UK Research and Innovation (n.d.-b).

Annex 2: respondents

We spoke to:

• Kristen Danielsen	Forskningsradet, Norway
• Emma Olsen	Vetenskapsradet, Sweden
• Daniel Bovelet and Ilka Paulus	DFG, Germany

Written information we received from:

• Riitta Maijala	Academy of Finland, Finland
• Trine Theodorsen and Thomas Hansen	DFF, Denmark
• Michelle Truman	UKRI, UK
• Isabelle Verbaeys	FWO, Flanders

In the Netherlands, we spoke to:

• Jeroen Geurts	UNL, VU
• Ciska Wijmenga and Nienke de Deugd	UNL, RUG
• Pancras Hoogendoorn and Kim Karsenberg	NFU, LUMC
• Marjolein Blaauboer	KNAW
• Jan de Boer	NWO-ENW, UvA
• Hans de Bruijn	NWO-SGW, TUD
• Margot Weijnen	NWO-TTW, TUD
• Huib Pols and Veronique Timmerhuis	ZonMw

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