International differences in basic research grant funding – a systematic comparison

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Section 0 (Executive Summary)

Using a structured systematic comparative approach, this study analyses differences in (basic) research grant funding between the main academic research funding agency of Germany (DFG) and the main agencies of five other countries (FWF in Austria, SNSF in Switzerland, NWO in the Netherlands, UKRI in the UK, NIH and NSF in the USA). A systematic survey of the literature was used to identify features of research grant funding which may impact on research outcomes (quality, quantity, direction of research, as well as productivity of researchers). We first point out structural differences between the DFG and the other agencies with respect to such features, before we summarise the potential impact of these differences on research outcomes.

Structural differences between the DFG and other agencies

Differences in the context for science funding

The agencies fund research activities in different **contexts,** framed by the higher education system, overall funding levels of academic research, the mission focus and governance structures of the agencies as well as overall scientific performance. The DFG operates in a chair-based higher education system, with a lower share of tenured researchers than in systems featuring more department-style university organisation as in the UK, the US or in the Netherlands. Non-tenured researchers may be more risk averse when they apply for grant funding to secure their position. At the same time, grant funding enables early career researchers to pursue their own lines of research, avoiding the limitations of hierarchically structured universities.

The share of the DFG's funding – i.e. the share of competitive grant funding - in total research funding of the higher education sector is higher than in Austria, similar to the Switzerland and the Netherlands, but (much) lower than in the UK and in the US. Block funding in Germany is not allocated using strict performance-based budgeting, similar to Austria, Switzerland and the Netherlands, but different to the UK and the US, where almost all of (academic) research funding is peer-reviewed (either ex-ante, through grant funding, or ex-post, through the Research Excellence Framework). The absolute level of DFG funding (per researcher) is also at the low end of the countries examined (except for Austria), while Switzerland, the US and The Netherlands spend more per researcher on grant funding. Overall this means that incentives set by competitive funding are rather low in Germany.

The DFG is set up as a research funding agency where academic researchers have a formal say in the DFG's principles and funding policies (academic self-governance), similar to the SNSF and the FWF; the other agencies are governmental agencies with only advisory roles for external academic researchers. Within its mission focus, the DFG is together with the FWF probably least targeting economic or societal impacts which may result of the research it funded. The DFG organises funding activities in a centralised, non-discipline specific way, similar to the SNSF and FWF, leading to an accessible funding menu for researchers by comparison with much more complex decentralised or discipline-specific agencies such as NIH or NSF, or by comparison with the 7 UK Research Councils.

Finally, the "performance" of German academic research is below that of the other countries examined in particular regarding universities. This may influence the choice of funding initiatives, e.g. more spending on funding schemes which build research excellence, such as the excellence initiative.

Differences in the funding portfolio

Similar to other countries, the DFG's main (single) project funding scheme "Sachbeihilfen" is the most important funding scheme, at about 30% of total. Unlike many other agencies, the DFG does not have a dedicated scheme for funding early career principal investigators, but it does have specific review criteria for them in the standard project funding scheme. Where the DFG stands out is the high share of structural priority funding in the form of the "excellence initiative", due to its funding of German universities with a view to increase their research excellence; and its low share of "translation" schemes (similar to the FWF, dedicated schemes for R&D collaboration, applied research, commercialisation schemes, do not exist within the DFG with the exception of clinical trials and the possibility to propose translational follow-up projects within the main project funding scheme). In terms of change in the shares of funding schemes, the DFG in line with other agencies has significantly raised the share of spending on research infrastructure (except for the FWF which does not have an infrastructure scheme).

Overall, the diversity of the DFG funding schemes is quite high, both in terms of the share of the three largest funding schemes as in terms of distinct funding schemes, only behind the NIH (NSF, NWO and UK data are limited for this purpose though). A high diversity enables agencies in principle to try different approaches and choose more effective ones based on evaluation, as well as responding to a variety of researchers' needs and characteristics (such as the challenges involved with interdisciplinary funding, support of early career researchers, high risk projects etc.).

In terms of the share of disciplines in research funding, the European countries are much more similar than the US, which due to the dominance of the NIH spends relatively much more money on medicine. As the other European agencies, the DFG spends most on natural sciences, although the share has been declining and is lower now than in Switzerland. Medicine is comparable across the European countries at a bit more than 20% (except for Austria, where it is lower), engineering is much higher in Germany than in Switzerland, Austria, the UK or the US. Social sciences and humanities are at a comparable value in the DFG and the UK at around 15%, higher in Switzerland and Austria at above 20% and much lower in the US.

Differences in grant design and characteristics

Concerning the main (single) project funding scheme, the success rate of 30% at the DFG compares favourably with the agencies of the other countries, with the exception of the SNSF (48%) and some smaller UK Research Councils. However, this is partly due to lower average lot sizes by comparison with most other agencies and a lower number of applications. By discipline, the DFG shows the highest success rate in engineering, although it aims at rather uniform success rates across disciplines; the SNSF shows higher differences between disciplines. The standard duration of single projects at the DFG is at the low end with 3 years, similar to the NIH and the NSF, but lower than in Switzerland and Austria (up to 4 years), the UK Councils (up to 5 years) and in the Netherlands (up to 6 years). However, a specific long-term proposal is possible of up to 12 years, and the standard grants can be renewed at a much higher success rate than new grant applications (similar to the NIH, although renewal is even more common there), compensating potentially both small lot size and short funding duration.

The DFG, FWF and SNSF single project-funding schemes are generally curiosity-driven, bottom-up schemes by contrast with the other agencies which often accommodate a mix of investigator-initiated and solicited research, with up to 40% of projects funded as solicited research. Moreover, other agencies fund research much more in thematic frameworks, providing a discipline-specific or challenge-driven context for research funding.

Regarding cost reimbursement, the DFG pays an overhead rate (indirect costs as a share of direct costs) of 22%, comparable to the SNSF (20%). NWO and FWF do not pay overheads whereas the US federal research grants cover in principle full indirect costs, which differ depending on the research institution from close to 30 to up to 69%; the average is around 50%. The UK follows a different system by paying 80% of full economic costs to the research institutions, including the research time of the principal investigator.

Peer review at the DFG is similar to the other agencies in that it follows a three stage process to ensure overall quality of the review process. Reflecting their academic self-governance, only in the DFG, FWF and the SNSF are second stage reviewers elected by the scientific community rather than chosen by the agency. Reflecting mainly country size, the DFG invites national and international reviewers for the first stage review, while smaller countries such as Switzerland mainly look for reviewers abroad, and the NIH and NSF look for reviewers mainly nationally.

The DFG does not assess non-scientific project merit, such as potential economic or societal impact, or the potential use of the knowledge created outside science, as is the case in all other agencies except for the FWF (at the SNSF, this concerns only self-declared use-inspired basic research projects). The amount of feedback provided to applicants is similar to other agencies; EPSRC and NWO send in addition first stage reviewer comments to the applicants, so that they can respond to the reviewers' comments.

Overall, the ***most pronounced differences across all agencies*** are the following:

Spending levels per capita/researcher differ by a factor of 3 between the bottom and the top agency. The share of the agencies' funding in total research performed in the higher education sector varies between 8 and 55%, implicating significant differences in the way research is conducted.

Grant success rates range from almost 1 in 2 proposals granted to less than 1 in 5, again considerably affecting the research enterprise. *Funding durations* vary between 3 to 6 years (and in specific cases even up to 12 years), but are partly mediated by *grant renewal*, which is quite common in some agencies and not possible at all in others.

Differences in funding portfolios are biggest with respect to *"translational" schemes*, including applied research, R&D collaboration with firms, commercialisation, etc. Correspondingly, the split between funding of applied and basic research ranges from 50% basic and 50% applied to almost exclusively basic. *Differences in funding policies* are biggest with respect to the mix between *bottom-up funding* of researcher-initiated projects (curiosity-driven) and *more top-down approaches* (with some agencies achieving close to 100% bottom-up funding and others 40% of solicited research in standard project funding), or thematic umbrellas for researcher-initiated projects. *Differences in peer review* are most pronounced with respect to whether only scientific merit is assessed, or also non-scientific impact, and whether applicants can respond to reviewers.

The reimbursement of indirect costs and the wages of (tenured) principal investigators - some agencies are not paying any overhead rate or wages of the principal investigators, while others grant full reimbursement of indirect costs and allow for either a teaching replacement or buying out research time.

Potential impact of differences in research grant funding on research outcomes

Despite a large literature, robust causal evidence for the impact of differences in research funding on research outcomes is rare. It often comes from standard single project funding and US biomedical research and relates mainly to the share of competitive funding in total academic research funding, as well as to receiving a competitive grant rather than block funding; and to indications that grant funding design matters, without being able to exactly pinpoint which differences matter in which way. Any link of structural differences in basic research grant funding to research outcomes needs as a result to be interpreted with care.

Potential impact differences will mechanistically arise out of the ***different focus of spending*** in terms of the various funding schemes outlined above, e.g. in terms of infrastructure and translational spending. Furthermore, independent of composition, the ***overall share of competitively allocated funding*** in total research funding should generate an impact on "quality". Competitive funding in both grant and block funding is particularly high in the UK and the US (almost exclusively grant-funded), while the Swiss SNSF has also very high funding per higher education researcher, although Swiss block funding is large and formally not allocated on a competitive basis.

When success rates are too low however, a high share of competitive funding can be very frustrating for researchers and lead to "hypercompetition": ***Low success rates*** limit the productivity of researchers and reduce the attractiveness of research institutions in countries faced with low success rates; they may lead to higher risk-aversion of researchers, in particular in combination with the employment situation of the researcher (whether she is on a fixed-term or permanent contract).

It seems to be easier to influence the quantity and direction of research than the quality of research. There are major differences between countries in the thematic context in which research proposals are submitted, between purely ***curiosity-driven, researcher-initiated within pre-defined fields and solicited research***. In countries with a higher thematic orientation we expect a corresponding impact on quantity and direction. E.g., the US should have a much larger share in medicine-related articles than Germany – controlling for size.

More fundamentally there is barely any systematic evidence on how the ***choice of research topic*** is related to the impact on research outcomes, including the question on whether there is a trade-off between "quality and direction". This concerns both the micro-level, in terms of researcher-initiated, bottom-up choice of research question vs. solicited, top-down choice, and the "macro" level, in terms of the governance of funding agencies (with the scientific community deciding mainly by itself what to focus on or with outside (governmental, societal) influence on the choice of research topic). It is neither clear whether more top-down competitive grant funding does achieve more benefits for society and the economy, nor whether purely curiosity-driven funding does achieve higher "quality" in terms of research outcomes.

More research is also necessary to formulate hypotheses on any impact from differences in the way ***peer review*** is organised. However, beyond a quality threshold, the way peer review is done may matter less for research outcomes than funding levels, success rates, and other grant features. ***Longer-term research horizons*** may foster risk-taking and lead to more breakthrough science; however, they may also foster specialisation in specific research strategies and discourage changing to new research lines. ***Renewability of grants*** may also act together with ***large lot sizes*** to provide continuous competitive funding of larger research groups, with again competing effects in terms of long-term research horizons and specialisation in established lines of research.

Full indirect cost reimbursement and ***refundability of the wages of principal investigators*** can dynamize the scientific enterprise in a country, through more dynamic scientific labour markets and faster growth/differentiation

of science, provided that funding by agencies keeps increasing; otherwise “hypercompetition” may result, in particular when non-tenured researchers are entirely funded by grants, rather than when tenured researchers buy out their teaching time or have their research time covered by a grant.

1. Introduction

Objectives of the study

This study aims at a systematic international comparison of the agencies responsible for basic research grant funding with a view to pinpoint structural differences between them which could impact on research outcomes (the quality, quantity or direction of research). We refer to these agencies also as "basic research grant funding organisations". We want to emphasise that this does not mean that the agencies only fund basic research – while some overwhelmingly fund basic research, others also fund research of a much more applied nature, and even developmental activities (e.g., close to 50% of the NIH funding is applied research, by comparison with 13% for the NSF; according to the UK Medical Research Council, two thirds of their funding goes to basic research, one third to applied research).[1] The distinction between basic and applied research is often fuzzy and some countries do not report statistical data on R&D by type of R&D (whether basic or applied research, or development). It is more appropriate as a result to talk about "(academic) science funding agencies", although some agencies also fund researchers in firms. We compare the main organisations in Germany (German Research Foundation DFG), Austria (Austrian Science Fund FWF), Switzerland (Swiss National Science Foundation SNFS), the Netherlands (Netherlands Organisation for Scientific Research NWO), the UK (the new umbrella organisation UKRI along with the seven original Research Councils: AHRC Arts & Humanities RC, BBSRC Biotechnology & Biological Sciences RC, ESRC Economic & Social RC, EPSRC Engineering and Physical Sciences RC, MRC Medical RC, NERC Natural Environment RC, STFC Science and Technology Facilities Council) and the US (NIH National Institutes of Health and NSF National Science Foundation). Except for Germany (the main interest of our contracting authority Commission of Experts for Research and Innovation EFI) and Austria, we selected these countries because of the performance of their science systems (section 4.1.4).

The objectives of the study as commissioned are in more detail as follows:

- A literature survey to identify characteristics of grant funding which can serve as a basis for a systematic comparison of basic research grant funding, based on the potential impact of these characteristics on research outcomes, inter alia of grant size, funding duration, success rates, review criteria etc.).
- An internationally comparable data base of the funding portfolios of the different agencies.
- Using these data, present the main characteristics of the activities of the agencies and changes of these characteristics, such as changes in the funding portfolio, in the timeframe 1997-2017.
- Based on the literature survey, interpret the differences between agencies and link them to potential impact on research outcomes.

Methodology and Study Outline

Our comparison is first based on a survey of the available literature on the potential impact of differences in the amount and in the way grants for basic research are allocated to researchers and institutions (section 2). The survey aims to be systematic in that it points out methodological differences between studies in particular as regards the statistical nature of the relationships between the variables studied (from conceptual to causal econometric). This survey leads to a range of characteristics at the level of the basic research grant funding organisations and at the level of individual funding schemes or instruments for which we look out when comparing the agencies (section 3.1).

[1] The OECD (https://stats.oecd.org/glossary/detail.asp?ID=2206, and Frascati Manual, 2015) provides the following definitions: Pure basic research is research carried out for the advancement of knowledge, without working for long-term economic or social benefits and with no positive efforts being made to apply the results to practical problems or to transfer the results to sectors responsible for its application. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Oriented basic research is research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognised or expected current or future problems or possibilities. Applied research is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes. For type of R&D in US federal R&D agencies, see https://www.nsf.gov/statistics/2018/nsb20181/tables/tt04-17.

In section 3, we provide characterisations of the agencies based on the same structure across all countries, notably a classification of the various funding schemes of each funding organisation according to a classification of types of funding schemes which we developed for the purpose of this study. This leads to long lists of funding schemes (altogether 241) which took up a considerable amount of resources but were nevertheless necessary as a precondition for developing an internationally comparable analysis of funding portfolios. The descriptions of the agencies in section 3 are self-contained, as they were individually sent for validation to the agencies. The comparative perspective is developed in section 4 which first describes the context for the agencies' activities, including the structure of higher education systems, the R&D funding landscape, differences in mission and governance of the agencies and the performance of the science systems. It then looks at differences in aggregate funding levels, i.e. at the relative amount of competitive grant funding in the various countries and at differences in the funding portfolios across the various agencies. Finally, it looks at differences in how the agencies allocate the money, using particularly the example of single project funding schemes, their cost reimbursement modalities and their peer review criteria.

Section 5 summarises the findings from the comparative analysis, stressing important structural differences between them and linking them to potential differences in the impact on quality, quantity and direction of research, using the insights from the literature survey.

Limitations

To the best of our knowledge, this study is the first of its kind to look more deeply into basic research grant funding from an international comparative perspective, often requiring own desk research rather than being able to use available sources. This leads us to the limitations of the study which are mainly linked to the limited budget and time available (the study was conducted between May and September 2018): The literature survey presents as a result a selection of the most important available literature, rather than a full list of all the relevant literature. Given 241 individual funding schemes to assess, we often take the agencies' own description of their schemes from their websites as a starting point and use this as well as the available application documents (information for researchers who want to apply to specific schemes) as a basis for our assessment in terms of funding type and characteristics. In fact, a considerable part of the work involved going through the application guidelines of the 241 schemes, as they provide a lot of information on the funding scheme characteristics. This leads necessarily to a bird's eye perspective which cannot go into the detail of each individual funding scheme, but which establishes important general features such as whether funding schemes invite researcher-initiated proposals or solicit proposals according to pre-defined research questions, whether they are discipline-specific, etc.

The funding organisations are different in many ways, not just in terms of what they fund, but also in terms how they fund (e.g., with respect to reimbursable costs, funding duration, etc.) and how much data they got on their activities. In most organisations, we had invaluable contacts to help us understanding their data and structures (see annex) and we want to express our gratitude for these efforts. In spite of the best efforts of our contacts, some agencies simply do not keep track in a systematic and detailed way of the money spent in detailed funding schemes, so that the quantitative characterisation of the funding portfolios of the Netherlands, most UK Research Councils and the US NSF is limited to more aggregate levels than necessary for a detailed comparison of funding portfolios; the financial information provided by these agencies e.g. in their yearly reports is structured in a more aggregate way than the funding schemes presented to researchers willing to apply for funds. The German DFG, the Austrian FWF, the Swiss SNSF and the US NIH by contrast provide detailed information on the funding schemes. Overall, the NIH provides the most detailed and publicly accessible information on what it spends money on and how, including success rates.

Moreover, we could not establish contact with all the agencies analysed, in particular with some UK Research Councils (AHRC, NERC, STFC), so that information on them is particularly sketchy.

After assessing the general data availability, we also prioritised some funding schemes over others to gain a fuller set of data. We focused on the standard research grant funding to principal investigators, which is present in all research funding organisations and probably most comparable across countries; it is usually also the scheme for which data availability is the best. Many other funding schemes (e.g., related to careers or to thematic priorities) are often more context-specific and would certainly require more effort in terms of understanding differences between them, even if data on them were available more consistently. Our study should hence be seen as a first step towards a more systematic understanding of basic research grant funding in different countries, providing a

rough picture of important differences between agencies and their funding policies. Apart from more information on funding schemes other than individual research grant funding, there are also other characteristics, such as the detailed differences in the way peer review is conducted, which clearly need more work and a higher budget than was available for our study. We are grateful for any comments and help which readers of the study have (Juergen.janger@wifo.ac.at). However, despite these difficulties, we hope that our study led to a considerable range of findings which shed much more light on the differences in the amount of competitive grant funding available in each country as well as in the allocation procedures of the available funds, and the way this may impact on research outcomes.

2. Differences in basic research grant funding and their potential impact on research outcomes – a review of the literature

2.1 An overview of the literature

In this review of the available literature, we present a broad overview of studies relevant for assessing how differences in basic research grant funding may affect the quality, quantity and direction of science or research, or the scientific productivity of researchers. A clear limitation of this survey is that it is mostly relevant for the classic project-based principal investigator (PI) funding, whereas the agencies usually run many more funding schemes, such as with respect to career development and infrastructure investment. Surveying the literature pertinent to these other funding schemes is outside the scope of this study.

We classify the available literature according to the strength of the relationship it finds between features of grant funding and our outcome variables of interest, i.e. quality, quantity and direction. For most of the literature, we provide a rough classification according to the following steps:

i) Mechanistic (the relationship follows logically from the grant features, no literature necessary to show a relationship);
ii) Conceptual reasoning (hypothesizing relationships based on the likely impact of grant features, but without data underpinning the relationship);
iii) Qualitative-descriptive (quantitative or qualitative data are used to describe a potential relationship)
iv) Correlation analysis (using data, but not able to show causality)
v) (Causal) econometric

Furthermore, we indicate the geographic and institutional context of the findings. We use the term "quality" very broadly to denote concepts such as novelty or creativity; the papers reviewed mostly use some form of bibliometric indicators to indicate "quality", e.g. as in relative citation frequencies. The terms quality, quantity and direction refer to features of the research funded, but often the impact of the research grant may also be with the productivity of researchers, i.e. e.g. higher quantity of articles published, or higher average quality over time for a given researcher.

While addressing objectives of higher quality or changed directions may be achieved relatively easy through e.g. increasing overall funding (funding more projects) or shifting funding to different areas, disciplines or problems, the main challenge for grant-based research funding is spotting "good" research (as in its potential for originality, or novelty, etc.). Funding decisions aim at avoiding both type I errors – funding the project although it should have been rejected – and type II errors – rejecting the project, although it should have been funded. To overcome the information asymmetry between the funder and the researcher asking for funds, every research grant funding organization practices peer review in various forms. Does the way peer review is organized potentially influence the quality, quantity and direction of research? But not just the way the review is organized, many other features of grant-based research funding may impact on the quantity, quality and direction of research, such as success rates, funding horizons, investigator-initiated, curiosity-driven vs needs-oriented, solicited research etc.

And research outcomes are not just due to the properties of the basic research grant funding system but will also be influenced by the context of the research system, such as by other funding sources for basic research (e.g., block funding in the form of general university funds GUF), research organization and career structures in the institutions hosting the researchers. In the following, we provide a rough overview of the following topics in a summary table.

1. Top-level characteristics (Funding levels, effect of obtaining grant funding, characteristics of agency)
2. Characteristics of individual funding schemes/instruments
3. Peer Review Process
4. Refundable Costs
5. Translation
6. Interaction effects of research grant funding with other conditions for research

Table 1: Relationship of characteristics of grant funding with research outcomes – a review of the literature

Research funding characteristic	Relationship with research/researcher outcomes at which level (individual-institution)	Robustness of finding on relationship	Geographic/institutional context of finding
1. Top-level characteristics: Funding levels, effect of obtaining grant funding, characteristics of agency			
Overall competitive basic research grant funding levels	Affects success rates (see below) and hence potentially quality, quantity of research and productivity of researchers; however, higher success rates do not necessarily lead to higher quantity as lot sizes can compensate (*Stephan*, 2012) (i.e. bigger rather than more projects)	Mechanistic/Conceptual reasoning	US NIH budget increase (US Biomedical research), see below success rates
Share of competitive basic research grant funding in total research funding	Higher quality/quantity at the institutional level: universities produce higher output when they are both autonomous and face more competition (e.g., through relying more on competitive grants for research funding (*Aghion et al.*, 2010), i.e. they are incentivised by a higher level of competitive research grants to improve research)	Causal econometric	US universities
	Quality at the individual level: projects funded by competitive funds on average have higher novelty compared to those funded by internal block funds, but not for lower status researchers (assistant professors, women, researchers not in top universities) (*Wang - Lee - Walsh*, 2018)	Econometric, but selection vs. treatment effect not clearly distinguishable	Research projects in Japan
Receiving a grant	Somewhat higher productivity (one additional publication) at the individual level (*Jacob - Lefgren*, 2011a, 2011b)	Causal econometric	NIH R01 grant (US biomedical research)
Decision structures of agency	Research funding follows previous research and funding allocation, rather than health needs of population, suggesting that scientists' deciding on their own on direction/allocation of funds is suboptimal from a societal perspective, additional oversight, incentives, feedback needed (*Fortunato et al.*, 2018; *Yao et al.*, 2015)	Conceptual reasoning, based on correlation analysis/insurance-based health opportunity index	US biomedical research
2. Characteristics of individual funding schemes/instruments			
Bundle of differences in grant design	Differences in funding duration, tolerance of failure, review process are likely to matter for quantity/quality (*Azoulay - Graff Zivin - Manso*, 2011)	Causal econometric for effect of HHMI appointment, but effect	US academic life sciences (NIH vs. HHMI grants; US biomedical research)

Research funding characteristic	Relationship with research/researcher outcomes at which level (individual-institution)	Robustness of finding on relationship	Geographic/institutional context of finding
		of incentive design cannot be isolated	
High funding duration	Higher quality/quantity (*Azoulay - Graff Zivin - Manso*, 2011); although part of a bundle of differences explaining performance effects of HHMI appointment, no individual effect of funding duration shown.	See above	See above
	Duration also depends on the (conditions for) renewability of grants	Mechanistic	
	Quality: creative accomplishments are associated with stable research sponsorship (*Heinze et al.*, 2009)	Qualitative-descriptive (20 case studies)	US and EU researchers in two fields (nanotechnology and human genetics)
	Quality/risk: when funding continues for some time after project funding ended, researchers can look for other sources – more risk-taking in first project (*Azoulay - Graff Zivin - Manso*, 2011)	See above	See above
High success rates	Potentially higher quality through higher attractiveness of countries/research institutions for talented researchers (*Janger-Nowotny, 2016*)	Quasi-experimental (stated choice experiment implemented through survey among researchers)	EU and US researchers
	Higher productivity of researchers due to less time used for grant proposals (*Stephan, 2012*)	Mechanistic	N/A
	Higher quality through more risk-taking, more long-term, fundamental research agendas, as opposed to short-term research projects with higher immediate translation potential (*Stephan, 2012, Alberts et al.*, 2014)	Conceptual reasoning	US (biomedical) research
Lot/grant sizes	Influences success rates and funding duration (a fixed amount of money can be spread over more projects)	Mechanistic	N/A

Research funding characteristic	Relationship with research/researcher outcomes at which level (individual-institution)	Robustness of finding on relationship	Geographic/institutional context of finding
	Only weak relationship between grant size and quality at the individual level, in general lower impact per dollar for larger grant holders (*Fortin - Currie*, 2013); giving more money to fewer researchers does not seem to pay off in terms of quality, on the contrary, at level of funding scheme impact correlates with number of funded applications (*Gallo et al.*, 2014), suggesting that reducing lot size to increase success rates could work (bearing in mind discipline-specific cost structures)	Correlation analyses based on bibliometric data	Canadian researchers from three disciplines; applications to US biomedical funding scheme reviewed by American Institute of Biological Studies
Funding of early career vs. established researchers	Proposal writing, and proof of track record are easier for established researchers (see also the Matthew effect in science (*Petersen et al.*, 2011); providing special application procedures/funding schemes for early career researchers may hence be beneficial to quality of research /productivity of researchers (*Albert et al., 2014*)	Conceptual reasoning/qualitative-descriptive evidence	US NIH average age of first grant, success rates of new investigators vs established investigators at NIH/NSF (see description of NSF in section 3)
Investigator-initiated/curiosity-driven vs. thematic programming/strategic/solicited research (research questions defined by funder)	Trade-off quality – direction? Standard discussion whether scientific outcomes can be planned or whether it must be left to curiosity of researchers to tackle challenges, starting with *Bush* (1945), see also *Sampat* (2012), but barely any systematic evidence on impact on quality, quantity and direction. Accounts defending curiosity-driven research often based on case studies of successful inventions (but successful inventions can also result from solicited research, see Manhattan/Apollo Project). Researchers do value research autonomy/independence highly so that responding to research questions asked by someone else would be inherently less attractive to highly talented basic researchers (*Agarwal - Ohyama*, 2012; *Janger - Nowotny*, 2016), affecting the recruitment capacity of research institutions; scientists of higher ability in academia sort themselves into basic rather than applied research. However, investigator-initiated grant funding cannot be directed towards solving specific applied problems, such as climate change, diseases, etc. (see *Mowery - Nelson - Martin* 2010) on the discussion of US federal R&D expenditure on IT	Quasi-experimental (*Janger-Nowotny, 2016*); predictions of labour market matching model confirmed by analysis of researcher data (NSF SESTAT) (*Agarwal – Ohyama, 2012*)	EU and US researchers

Research funding characteristic	Relationship with research/researcher outcomes at which level (individual-institution)	Robustness of finding on relationship	Geographic/institutional context of finding
Curiosity-driven research within broad thematic fields/disciplines defined by funder vs. no thematic requirements (pure bottom-up)	Quantity and Direction**:** Research follows the money (impact of states, defence, medical research expansion on even top university strategies such as Stanford, see *Stephan, 2012*); thematic focus not just through funding scheme, but indirectly through who pays	Qualitative-Descriptive (Case Study)	US (NIH, Defence)
Interdisciplinary vs. single discipline funding	Although the combination of previously disconnected ideas (as interdisciplinary research, but not only) often leads to novel ideas (*Larivière - Haustein - Börner*, 2015), reviewers often give lower scores to novel ideas/interdisciplinary research (*Bromham - Dinnage - Hua*, 2016; which may explain why the highest impact papers usually feature a combination of new and established elements, see *Fortunato et al.*, 2018).	Descriptive statistics based on bibliometrics (interdisciplinary articles receive higher mean relative citation rates; *Larivière - Haustein - Börner*, 2015) Quantitative analysis of applications to funding scheme (*Bromham - Dinnage - Hua*, 2016)	Based on all sub-disciplinary combinations Applications to Australian Research Council Discovery programme
Funding of projects vs. of people	Higher quality/quantity at the individual level: funding of people is more flexible when some research approaches fail by contrast with project funding requiring pre-defined deliverables – more experimentation possible because early failure is tolerated (*Azoulay et al., 2011*); this also leads to an impact on the direction of research (more novel exploration); although part of a bundle of differences explaining performance effects of HHMI appointment, no individual effect of funding people vs. projects shown. Policy literature also recommends funding of people rather than of projects (*Albert et al., 2014*)	See above	See above
3. Peer review process			
General quality of review process	A single best-practice model is difficult to pin down, depends on funding context and objectives; differences between reviewers of same project suggest that funding decision	Quantitative analysis of reviewers' scores (single-rater reliability)	Australian research council

Research funding characteristic	Relationship with research/researcher outcomes at which level (individual-institution)	Robustness of finding on relationship	Geographic/institutional context of finding
	often not much different from chance decision (*Marsh et al., 2008*); research on bias in peer review not very conclusive (*Lee et al.*, 2013)		
	Moderate positive correlation between peer review scores and citation-adjusted bibliometric output suggests peer review was working in particular instance of applications to a US biomedical funding scheme (Gallo et al., 2014), but no pinpointing of specific features	Correlation analysis based on bibliometric data	Applications to US biomedical funding scheme reviewed by American Institute of Biological Studies
	Quality - better peer-review scores are consistently associated with better research outcomes (*Li - Agha*, 2015)	Correlation analysis based on bibliometric data	US biomedical research (NIH R01 grants)
"Quality" of reviewers	Potentially higher quality when pool of reviewers as large as possible, both geographically and in terms of fields – reviewers from too narrow a field may take on a too insular view (in particular in review panels) (Albert et al., 2014); make it compulsory for grant holders to serve as reviewers	Conceptual reasoning	US biomedical research
	Reviewers tend to score lower both proposals closer to their own field and highly novel proposals (*Boudreau et al.*, 2016)	Causal based on randomised experiment	US researchers
	Less quality when reviewers nominated by applicant herself (systematic bias in peer review), (*Marsh - Jayasinghe - Bond*, 2008)	Qualitative-descriptive analysis of application data	Australian research council
	Many factors other than research "quality" may shape outcome of review process (procedures, distance between evaluator and applicant, proposal formats, applicant characteristics such as gender etc.), but bias not necessarily effective/appropriate assessment criterion (*Lee et al.*, 2013; *Marsh - Jayasinghe - Bond*, 2008)	Surveys	US/Australia
Evaluation of applicant	Potentially higher quality when qualitative focus on major scientific achievements rather than number of journal articles (Albert et al., 2014)	Conceptual reasoning	US biomedical research
Selection criteria – track record vs quality of proposal	Higher agreement between reviewers (higher single-rater reliability) for assessment of track record of applicant/research team than for project proposal (*Marsh - Jayasinghe - Bond*, 2008)	Quantitative analysis of reviewers' scores (single-rater reliability)	Australian research council

Research funding characteristic	Relationship with research/researcher outcomes at which level (individual-institution)	Robustness of finding on relationship	Geographic/institutional context of finding
Selection criteria - gender	Equal success rates for women and men at NIH grants, but drop of female scientists in first-time R01 applicants after postdoctoral stage (*Ley - Hamilton*, 2008), suggesting that other context factors at play	Descriptive funding statistics	NIH grants (US biomedical research)
Selection criteria - applicability of findings, potential impact	Need to show short-term impact, applicability of basic research may not lead to innovative research (*Linden*, 2008); see above discussion on curiosity-driven vs. solicited research; similar discussion as for demonstrating feasibility of the proposed approach (*Stephan, 2012*)	Conceptual reasoning - Qualitative (Case studies and interviews)	UK biomedical research
Amount of feedback provided to applicant	Higher quality (*Azoulay - Graff Zivin - Manso*, 2011); although part of a bundle of differences explaining performance effects of HHMI appointment, no individual effect of amount of feedback in review process shown. Also trade-off with time of reviewing researchers.	See above	See above
4. Refundable costs			
Treatment of indirect costs	Full reimbursement of actual indirect costs – incentives for research institutions to more actively seek grant funding, e.g. through recruitment of talented researchers and incentives for scientific productivity of established researchers; In general allows research institution to act more strategically in order to build up reputation and prestige, which may in turn affect its attractiveness for talented researchers and hence foster quality; and spurs competition between universities (*Janger*, 2013); effect of incentives for more actively seeking competitive grant funding see above Aghion et al., 2010 (share of competitive grant funding in total research funding)	Conceptual reasoning: Aghion et al., 2010, see above	N/A
	Allows for venture capital model of science (or "high-end shopping mall-model" – *Stephan, 2012* – research institution hires young promising researchers, gives them start-up packages, recoups costs by income from indirect costs on grant funding (together with salary covered by grant); enables research institution to hire further researchers -> quantity, accelerates the growth of science; more dynamic labour market in academia	Mechanistic/Conceptual reasoning	US universities
	May also lead to unsustainable growth of the number of researchers and number of applications when overall research funding does not increase, leading to low success rates and "hypercompetition" (Alberts et al., 2014)	See above	

Research funding characteristic	Relationship with research/researcher outcomes at which level (individual-institution)	Robustness of finding on relationship	Geographic/institutional context of finding
	Quality - allows for hiring when talent is available, not according to rigid predefined replacement patterns	Mechanistic	N/A
	Direction - makes it easier to build up new lines of research, new disciplines	Mechanistic	N/A
	Fixed indirect cost rate below actual indirect costs may also distort competition between researchers from different research institutions, leading to erroneous quality signals (*Meurer - Nicole Schulze*, 2010)	Conceptual reasoning	German research institutions
Salary of principal investigator (PI) refundable	i) Higher quantity (scientific productivity over the life-cycle), as it may incentivise established researchers to do own research rather than write proposals for PhDs/post-docs) *(Janger, 2013)*, and may hence ii) also affect emergence of new fields (direction), as tenured researchers can choose riskier research projects (see *Foster - Rzhetsky - Evans*, 2015)	i) Conceptual reasoning; ii) quantitative analysis of publication data ("search paths")	ii) Medical research
	Higher quantity, as research institution has more leeway in employing additional researcher-teachers as a function of grant income rather than base funding	Mechanistic	N/A
	Higher productivity of researchers, when researchers can buy themselves out of teaching	Mechanistic	N/A
	See also above for indirect costs – dynamics of scientific differentiation are accelerated, universities can act more strategically and hire talented researchers as they become available	Conceptual reasoning	N/A
	May be bad for quality through lower risk-taking (*Stephan, 2012*), when salary depends on obtaining grant (i.e. when non-tenured researchers' salary depends on grants)	Conceptual reasoning	US
	May be bad for quantity, when the salary of many non-tenured researchers is financed by grants and research funding does not increase (*Alberts et al., 2014*), so careers end	Conceptual reasoning	US biomedical research
5. Translation			
R&D collaboration with firms	Lower quality when too much cooperation with business, some collaboration beneficial (*Banal-Estañol - Jofre-Bonet - Lawson*, 2015)	Causal econometric	Data of UK EPSRC funded projects, all researchers employed in

Research funding characteristic	Relationship with research/researcher outcomes at which level (individual-institution)	Robustness of finding on relationship	Geographic/institutional context of finding
			UK university engineering departments
6. Interaction effects of research grant funding with other conditions for research			
Interaction of research funding with research organisation at working unit level	Higher quality, productivity: Competitive research grant funding can enable independent early career researchers in otherwise hierarchical chair-based organisation of research (*Whitley - Gläser - Engwall*, 2010)	Conceptual reasoning	N/A
Interaction of research funding with career structures	Researchers on short fixed-term contracts have to prioritise less risky, short-term projects (*Petersen et al.*, 2012), so grant-based research funding with lots of fixed-term researchers may produce lower quality research (career pressure works as an incentive for conservative behaviour)	Theoretical model based on analysis of bibliometric data	300 (leading) physicists
Interaction of grant funding with government block funding	If block funding not very competitive, higher amount of competitive grant funding can lead to higher quality (*Aghion et al., 2010*)	Conceptual reasoning	N/A
	Quality - projects funded by competitive funds on average have higher novelty compared to those funded by internal block funds, but not for lower status researchers (assistant professors, women, researchers not in top universities) (*Wang - Lee - Walsh*, 2018)	Econometric, but selection vs. treatment effect not clearly distinguishable	Research projects in Japan
Interaction of grant funding with university-internal funding	Higher productivity of researchers: Start-up packages (as now common in the US, *Stephan, 2012*) for new early career recruits help starting up research, so that later grant writing and probability of success are higher	Conceptual reasoning	US universities

2.2 Discussion of the available literature

Overall, much of the literature is focused on US biomedical research (which is quite unique in several regards, see below) and few papers are able to establish causality (see also Fortunato et al., 2018, p. 9, for the strand of "Science of Science"-studies, i.e. data-intensive studies of science: "Assessing causality is one of the most needed future developments in SciSci: Many descriptive studies reveal strong associations between structure and outcomes, but the extent to which a specific structure "causes" an outcome remains unexplored"). We first summarise the results from the literature survey and then discuss open questions.

2.2.1 Synthesis of the literature

Research quality

There is strong evidence only for the total amount of competitively granted funding (although see the discussion below on a potentially inverse u-shaped relationship), resp. the share of competitive funding in total (basic, or academic) research funding to affect research outcomes, as well as for the way grants are designed.

Success rates may influence research quality through higher-risk aversion, in particular in conjunction with researchers employed on fixed-term contracts; and through the attractiveness of research environments, in that institutions/countries offering higher success rates are more attractive for mobile talented researchers.

Funding duration may influence risk-aversion and the transformative nature of the research proposed, in particular again in conjunction with the nature of the employment contract (fixed-term vs. tenured). However, too long a funding duration may also set fewer incentives for researchers to leave settled research agendas and engage in more novel and risky directions (block funding provides in principle long-term research horizons, but does not set incentives for change). Funding duration of grants can vary substantially according to whether a grant can be renewed or not.

Grant sizes mechanistically influence success rates and funding duration, but there is a priori no clear relationship with quality. Large or unlimited grant sizes can mechanistically play together with renewability of grants to enable the continuous funding of larger, equipment-intensive research groups, enabling longer-term research perspectives.

Special review criteria or funding schemes for early-stage investigators, multi/interdisciplinary and highly novel or risky research may be positive for research quality, as all are at a disadvantage in the standard peer review process when compared with established researchers/single-discipline proposals or research which follows more established lines and is hence judged as more feasible). Selecting people rather than projects may also be more beneficial for research outcomes.

More able researchers select themselves into more basic research, and researchers generally value being able to ask their own research questions (to be autonomous in setting their research agendas). Solicited research or review criteria which ask for impact (i.e. for potential applications of the knowledge generated) may hence limit novelty (but see below the discussion on a potential trade-off between quality and direction).

The overall quality of the review process matters; reviewer pools need to be as large as possible and giving applicants the right to nominate reviewers may be bad for quality, while a lot of feedback given to applicants improves their chances for later successful application.

Fully reimbursable indirect costs and principal investigators' salaries may enable universities to recruit new researchers when there is talent available rather than only when they need to replace retiring researchers; and they may lead to more dynamic growth of science, fostering the emergence of new fields, as well as generally allowing universities to act strategically in order to improve reputation and prestige, hiring talented researchers, providing them with start-up funds and then benefitting from the grants researchers bring in at a later stage (the "venture capital model of science"). However, they may also draw more researchers into careers in academic research which then needs a corresponding increase in overall research funding, otherwise the increased number of researchers may lead to decreasing success rates (see discussion below); and when non-tenured researchers depend on grant income, risk aversion may follow.

Cooperation with firms, or working on more applied problems, is beneficial up to a certain extent, but too much reduces publishable research outcomes.

Researcher productivity

Success rates matter mechanistically strongly for researcher productivity, not just through time spent on proposal writing; more speculative are effects of low success rates on collaboration, lab atmosphere etc. Receiving or having to apply for a competitive grant also increases productivity relative to block funding (in the case in which block funding itself is not allocated on a competitive basis); moreover, in hierarchically organised working units of research institutions (e.g., in chair-based systems), competitive grants help researchers who are not at the top of the hierarchy to be independent and establish their own lines of research. Reimbursable salaries of tenured PIs may set incentives to keep up scientific productivity over the life cycle, as established researchers will do research themselves, rather than writing proposals to employ post-docs; it also allows them to buy out of teaching. The amount of feedback provided through the peer review process will also help researchers to improve. University-funded internal start-up packages help researchers to advance their research so that it is ready for being proposed to external grant funding.

Quantity

Overall funding levels influence the quantity of research produced through the extensive margin (more researchers are able to do research) while the factors affecting researcher productivity (see above) influence quantity through the intensive margin (the same researchers can do more research). When grants cannot fund PI's salaries, or do not cover indirect costs, so that some of the research institutions' non-grant funded budget needs to cover costs associated with the research funded, the number of researchers will mainly grow at the PhD and post-doc level, as the higher number of proposals which can be funded can only fund this type of researcher. This may lead to sharp pyramids in research institutions, with few tenured researchers at the top and many non-tenured post-docs at the bottom. When grants can fund non-tenured PIs and overall funding does not increase, the induced growth of researchers may lead to low success rates.

Direction

Funding thematic priorities, or simply providing funding for defined fields/topics (while leaving the choice of the research question to the researchers), seems to be able to quite easily steer research efforts towards these fields or topics, even in top universities. In general, research funding opportunities will be taken advantage of in an environment of scarce funding. The governance of agencies may also influence direction, academic self-governance may lead to more curiosity-driven research rather than challenge-driven research (or to scientists having a greater role in determining the choice of research questions).

Agencies can also simply issue calls for research on specific problems (solicited research; see the discussion below however on a potential trade-off with quality), or make economic or societal impact a review criterion even in curiosity-driven, investigator initiated funding schemes. In the latter case, it is however not clear a priori how this affects direction.

Reimbursing indirect costs and PI's salaries (or funding a teaching replacement) makes it easier to establish new lines of research, as researchers are not bound by the thematic requirements of their research institutions.

In the following, we discuss some open questions emerging from the literature survey. This will due to the limited scope of our project necessarily remain incomplete.

2.2.2 Open questions

- Intricacies of peer review process – does the peer review process lead to higher quality outcomes?

While some studies report a positive correlation between peer review scores and later research outcomes, the subject of how to best organise a peer review process is in general very difficult. There are few studies able to isolate the impact of specific differences in the peer review process (*Marsh - Jayasinghe - Bond*, 2008), not to mention in cross-country contexts. There is a large literature on potential bias in peer review, but definitely no simple prescriptions for optimal peer review organisation, with the exception of some basic features such as assessing projects vs. people, independent reviewers, difficulties of early stage researchers etc. (see above). Beyond such basic features, differences in impact of basic research grant funding organisations may be less linked to differences in peer review, but more to other features examined here, such as overall funding levels, success

rates, funding duration, curiosity-driven vs. solicited research etc.; in a nutshell, the process of peer review may be less relevant for explaining differences in the impact of basic research funding agencies, beyond a certain threshold which assures the quality of the review. This is purely speculative however, based on the assessment of the available literature and the knowledge about the differences between the agencies described in the sections 3 and 4.

A topic becoming more important is whether the peer review process is properly taking account of varying team productivity against the background of the increasing importance of team-based scientific knowledge production (*Wuchty - Jones - Uzzi*, 2007). *Petersen et al.* (2012) observe that the track record of researchers is influenced by team and collaboration structures, so that assessing the potential of applicants would need not just individual success measures but also measures of team output as a basis for funding decisions.

- Investigator-initiated, curiosity driven, bottom-up vs. solicited, thematic, top-down research

This discussion comes in many guises; a first distinction is whether principal investigators define the research question completely independently (investigator-initiated, curiosity-driven, bottom-up) or whether they respond to calls by the basic research funding agencies, i.e. where research questions are framed by the agency (solicited research, top-down). A second distinction is whether principal investigators define the research question (initiate the research) without any broad thematic framework provided by the funder ("bottom-up") or whether principal investigators propose their projects within broad thematic fields defined by the funder. A third distinction is whether selection criteria in the peer review process emphasize potential applicability of findings, or economic/societal impact even in curiosity-driven, investigator-initiated research funding or only look for research quality/originality/novelty (i.e., criteria of scientific quality) without regard to later (non-scientific) impact.

The existing literature often mixes these three different characteristics of basic research grant funding. Apart from the evidence that (in particular highly able) researchers prefer research autonomy and independence, i.e. asking their own research questions, there is barely any systematic evidence on the potential impact of these different ways of allocating grant funding. The discussion is completely absent in the recent survey article by *Fortunato et al., 2018*, who discuss several topics based on quantitative-data articles.

Defence of purely bottom-up curiosity-driven research against stakeholders asking for more immediate impact and targeting of research funding is usually based on case studies, on accounts how applications arose out of serendipity (see *Sampat, 2012*) and on the general argument that the outcomes of scientific activities are inherently uncertain and hence cannot be planned. However, standard investigator-initiated grant funding cannot be directed towards solving specific applied problems, such as climate change, diseases, etc., beyond the level which happens naturally due to scientists' curiosity; while of course, case studies would also show that important applications followed from targeted/solicited research, as in the Apollo or the Manhattan Projects.

Two important questions are hence whether there is a trade-off between quality and direction, i.e. whether solicited research is of lower novelty, originality etc. than purely curiosity-driven research, and whether curiosity-driven research may take more time to address problems perceived as pressing by society. Such questions should be able to benefit from better data availability. The big challenge for science at the moment may be to increase the rate of research in a specific direction (*Bailey - De Propris - Janger*, 2015; *Foray - Phelps*, 2011), given major challenges such as climate change. A second related question is more conceptual and asks whether the decision on what to fund can be entirely left to the scientific community in terms of single-project peer review ("where the direction of where research should go [is] largely a function of the prevailing views within the scientific community", *Sampat, 2012*). This will also be influenced by how the basic research grant funding organisations are set up, with strong participation by the scientific community not just in peer review, but also in setting overall policies (as in academic self-governance) vs. a more limited role of the scientific community in peer reviewing proposals, while overall fund policies are set by more managerial procedures in governmental agencies.

- Translational research

The discussion above on curiosity-driven vs. targeted research also relates to the discussion on all kinds of "translational" research, which may come in many guises (e.g., funding commercialisation of basic research, R&D cooperation with firms, applied research, etc.) and which is practiced by the basic research grant funding agencies to very different extents (see section 3), also depending on the funding landscape in the countries; e.g., there may

be dedicated innovation funding agencies separate from basic research grant funding agencies. In principle, purely funding commercialisation of basic research should not alter the research itself, unless commercialisation efforts already start at the conception or review of research proposals (see above). Research outcomes are more likely to be altered when the research itself is influenced, e.g. by research collaboration with non-academic researchers or specific review criteria. In US biomedical research there is a concern that translation is becoming overvalued at the expense of purely curiosity-driven research (*Zoghbi*, 2013). *Banal-Estañol - Jofre-Bonet - Lawson*, 2015, report negative effects for academics' research outcomes when there is too much cooperation with business. Otherwise, there is little evidence on this, with the exception on the literature of whether academic patenting affects scientific productivity, which is often independent of basic research grant funding.

- Choosing new directions within curiosity-driven research and renewability of grants

Choice of research problem can in principle be between further specialisation in an established line of research, or diversification into new areas, with the first being the "safer" and more productive route, and the second being the "riskier" route, with both breakthroughs and failure more likely (*Fortunato et al.*, 2018). Such choice may be influenced by several grant funding characteristics, such as funding projects vs. people (with funding of people potentially facilitating change of direction), emphasizing novelty and risk in the peer review process, refundability of indirect/salary costs (as researchers are less bound by thematic requirements by their research institution), and funding duration. A long funding duration enables long-term research agendas which may be more conducive to riskier research, but at the same time long funding duration may also set fewer incentives to change direction and hence to specialise in established lines of research. This is seldom discussed in the literature, in particular in combination with the topic of renewability of grants, which at some agencies such as the NIH (otherwise criticised for short funding durations) is quite common, with higher success rates for renewal than for first-time applications. Renewability of grants enables longer funding duration, but the effects are unclear.

- Can there be an inverse u-shaped relationship between the amount of competitive funding in total funding and risk/quality/productivity?

In *Aghion et al., 2010*, there is no evidence of an inverse U-shaped relationship between the share of competitive grant funding in total research funding and the quality of research. *Wang et al., 2018*, also show more novelty from competitively funded research projects vs. block-funded research projects, but not for lower status academics (not in the top research universities, assistant professors, women). *Stephan, 2012*, discusses advantages and disadvantages of competitive grant vs block-funding systems, with the former setting more incentives for scientific productivity, in particular over the life cycle of researchers, but potentially limiting the choice of risky projects depending on grant characteristics (success rates, funding duration etc.), whereas the latter set fewer incentives for scientific productivity, but may enable longer-term research agendas. This only holds in the case of block funding being allocated to universities without many strings attached, or e.g. simply based on input parameter such as the number of students; block funding can also be allocated based on peer review of publication output, as in the UK through the Research Excellence Framework.

From qualitative-descriptive accounts, not all seems to be well however in a very competitive grant-based system such as the US biomedical research system (*Alberts et al.*, 2014), when the number of researchers keeps growing (or the expectation is maintained that the system will continue to grow forever) but research funding does not. By *Alberts et al., 2014*, p. 5774, own words: "Competition in pursuit of experimental objectives has always been a part of the scientific enterprise, and it can have positive effects. However, hypercompetition for the resources and positions that are required to conduct science suppresses the creativity, cooperation, risk-taking, and original thinking required to make fundamental discoveries."; Hypercompetition for jobs and promotion also alters publication practices and the work atmosphere in the lab; an increasing number of results which cannot be replicated may also endanger the trust of the public in science, and growing numbers of PhD graduates and post-docs, linked to the doubling of the NIH budget at the end of the 90ies, also led to the increasing of the average age of receiving a first NIH grant. In 1980, 16% of NIH grants recipients were 36 years old or younger, while that same number is now at 3% (*Alberts et al., 2014*).

This picture of US biomedical research is largely driven by the drop in NIH success rates from around 30 to 20% (see section 3). Higher shares of competitive research funding clearly need corresponding success rates to work. The US biomedical research system experiences however also the effects of the role of indirect costs' and PI-

salaries' reimbursement for the growth of the scientific enterprise. If the latter are absent – as for a long time in Europe – there is much less dynamic growth of science, as positions at universities are limited by universities' block funding income which changes only slowly, often leading to replacement strategies of retired researchers potentially limiting the growth of new scientific fields. When non-tenured researchers can however do research purely funded by grants, higher growth in the number of researchers becomes dependent on increasing competitive funding levels, otherwise the rising number of applications is not matched by rising funds. So indirect/salary cost reimbursement can dynamize a scientific system, but also lead to unsustainable growth patterns. *Alberts et al., 2014* suggest several avenues for reform (in parentheses our discussion or explanation of the avenues proposed):

- Longer-term funding perspectives (longer-term budget plans for basic research funding agencies), so researchers and research institutions can plan accordingly (and certainly a one-off increase to re-establish higher success rates)
- Funding graduates through training grants and not research grants (to slow growth of entrants; of course this would place more competition at the entrance to an academic career)
- Limit the number of post-docs or increase their cost through various mechanisms, including using more staff scientists (reflecting the intensive use of post-docs in the US due to their relatively cheap labour costs)
- More long-term funding of people rather than projects (see above)
- More specific funding of early career investigators (as in the NIH New Innovator Award)
- Evaluation criteria during review should focus on novelty, quality, long-term objectives rather than on technical details
- Reconsider full reimbursement of indirect costs (e.g. for loans on buildings investment), and the provision that 100% of salary costs can be funded by grants (there could be several ways next to reducing the percentage of costs reimbursed – e.g. limiting salary reimbursement only to tenured researchers, or limiting the number of projects with full cost reimbursement for non-tenured researchers)

It needs to be borne in mind that the biomedical research enterprise in the US is quite unique due to the high share of overall research funding it gets, linked to easier Congress approval for medical research funds (see *Stephan, 2012*, and NIH characterisation in section 3). One way to reduce negative effects of competitive grant funding by comparison with block funding, or disadvantages for early career researchers, is to provide a start-up package from university-internal funds which allows researchers to get their research going so that they eventually can apply for competitive funding (*Stephan, 2012*). How risk is affected by project grant funding also depends on the regulation and oversight of the science funds, e.g. in the US the *Office for Management and Budget* provides guidelines for the evaluation of research funding organisations which stress the importance of risk in research funding, prompting *Cozzens,* 2007, to argue that risky research is institutionalised as a core value of US research.

Overall, the discussion of indirect costs and salary reimbursement is very relevant for the current discussion in Europe, which is starting to introduce these features more frequently.

- Conclusion

There is good causal evidence that both the level of competitive research grant funding (*Aghion et al., 2010*) and the way grant funding is designed (*Azoulay et al., 2011*) are likely to matter for research outcomes. However, there is little empirical evidence on the importance of the myriad ways in which (basic) research grant funding can be allocated; and the evidence there is is mainly from the US, and in particular from US biomedical research. Due to the potential interaction of design features of competitive research grant funding with other funding sources, research organisation, career structures and university governance, lessons learned in the US must be applied with care in different national (basic) research contexts.

Success rates are definitely a major factor affecting the impact of basic research grant funding, as low success rates reduce researchers' productivity and through hypercompetition may also negatively affect other elements of the scientific knowledge production process, such as collaboration. Of course, very high success rates may also imply that more projects get funded which should not have been funded.

The diversity of findings with respect to peer review, grant characteristics etc., seems to suggest as the only safe lesson for the practice of basic research grant funding to not put all of your eggs in the same basket. The often

inconclusive empirical evidence calls for experimentation with different formats and then an evaluation of the results. Only a diversity of funding schemes seems to be able to address the various objectives of grant funding, although a diversity of funding schemes also asks for corresponding budgets by the basic research grant funding agencies. Too small funding schemes may be inefficient from an administrative viewpoint.

Examples for diversity are offering funding schemes more geared towards pure project funding, enabling productive research in established lines of research, at the same time as others more looking towards enabling new directions in science or the emergence of new fields, emphasising risk. *Foster - Rzhetsky - Evans*, 2015, recommend more aggressive funding of risky projects. Funding schemes can address the difficulties of early career researchers both through specific review criteria within funding schemes, or through separate funding schemes.

The same holds true for bottom-up vs. top down funding (PI-initiated vs solicited, or thematic focus) – although important progress comes out of purely curiosity-driven science without any direction by the funder, other progress also comes out of research with a thematic focus pre-defined by the funder. Directed science – e.g. the man on the moon ("Apollo Project") and the splitting of the atom ("Manhattan Project") - and federal US R&D expenditure on IT, driven by the defence mission and often done through contracts rather than principal-investigator driven grants (*Mowery et al., 2010*), also led to progress, although these examples were probably more involving applied technological development and not just basic research. In any case, influencing the direction of research may be easier than influencing the quality, as more money can simply be provided for specific areas (in targeted schemes, not in bottom-up PI-initiating schemes).

When interdisciplinary projects consistently get lower scores by peer reviewers, but produce higher impact, then introducing a separate scheme for interdisciplinary research may make sense.

3. A systematic characterisation of (basic) research funding agencies in selected countries

The next section describes our methodology for systematically characterising research funding agencies of varying countries. We then present self-contained sections describing the agencies, which serve as a basis for the comparative analysis in section 4.

3.1 A classification of basic research grant-funding agencies and funding schemes

A prerequisite for characterising the various funding schemes and instruments consists in assigning them to common funding scheme types, to be able to compare the agencies' activities according to comparable types of funding schemes. This is also necessary to build a comparable dataset of funding portfolios. To the best of our knowledge, no commonly accepted way of classifying funding schemes exists, so that we develop our own classification. The logic of this classification follows simply the aim and the modalities of the funding scheme (e.g., fostering mobility of researchers, or simply fostering research through individual projects, etc.). The broad types are project funding, priority areas, infrastructure, funding of people, translation, scientific communication and international cooperation. This classification is able to cover almost all funding schemes currently run by the funding schemes, with very few exceptions. One drawback of the classification is that a funding scheme can only be assigned to one type, although sometimes funding schemes pursue several goals at the same time or can accommodate different types of proposals, e.g. in the UK the standard grant mechanisms can usually fund both single- and multi-investigator projects, or single- as well as multi-disciplinary projects. Funding schemes are made flexible, e.g., by applying different review criteria or different sets of review panels to, e.g., early career researchers or interdisciplinary research proposals. However, adding a second or even third objective would have become too complex given the scope of the study.

Table 2: Classification of funding schemes and instruments

Funding scheme/instrument category	Description
Project funding	
Single project funding (SPF)	The standard funding of single principal investigator-led research projects
SPF early career	Single project funding for early career researchers, where early career refers to all non-tenured researchers and/or first-time applicants
SPF high-risk	Single project funding with a special emphasis on high-risk projects
Networks and multi-project funding	Funding involving collaboration between several researchers/PIs, often located at different institutions, e.g. research clusters or consortium grants
Interdisciplinary research	Funding of research projects requiring interdisciplinary collaboration or approaches
Priority areas	**Larger-scale, coordinated funding schemes**
Structural priority area	Funding with a view to strengthen research excellence and international visibility
Thematic priority area	Dedicated funding for research on predefined topics, such as global challenges or emerging fields
Infrastructure	**Funding of equipment outside equipment funded in standard project funding**
Funding of People	
Education & Training	All pre-doctoral funding (incl. PhD-training) of potential researchers with a view to train students for research careers or attract people into research careers, including programmes

	aimed at non-university students (e.g. interest in science & technology at school)
Career	All post-doctoral funding of researchers with a view to improve career perspectives
Mobility	Funding of international researcher mobility and exchange programmes
Diversification	Funding of researchers with a view to diversify the researcher population according to gender, race, social background etc.
Prizes	Awards for researchers, including distinctions for lifetime achievements but also early career prizes
Translation	**All funding aimed at fostering the use of basic research for further applications**
Applied Research	Funding of applied research within higher education settings
R&D Collaboration with firms	Collaborative R&D project funding
Commercialisation	Funding commercialisation of research results
R&D Value Chain	Funding of all aspects of research, starting from basic research, to applied research and experimental development as well as commercialisation
Scientific Communication	**Funding of dissemination activities, communicating science to a non-researcher audience**
International Cooperation	**Funding for improving bilateral research cooperation between countries**

This classification of funding schemes or instruments allows for substantially reducing the complexity of the science agency's activities from 428 (241) to 124, to be able to make structured comparisons and build a dataset of funding portfolios (see Table 1).

Table 3: Classification of funding schemes or instruments, 2017

Country	Agency	Original	WIFO classification
DE	*DFG*	37	12
AT	*FWF*	20	15
CH	*SNF*	31	14
NL	*NWO*	13	9
UK	*AHRC*	13	8
	BBSRC	10	7
	EPSRC	10	8
	ESRC	5	5
	MRC	15	12
	NERC	8	6
	STFC	15	8
US	*NIH*	242 (55)	13
	NSF	9	7
		428 (241)	**124**

Note: The number in brackets shows the sum of funding categories actually used by the study authors (all NIH activity codes with a share in total funding of more than 0.3%).

An even broader classification would further synthesise these broad types into

- Funding the creation of knowledge (Project, Priority Projects, International Cooperation)
- Funding use/diffusion of research (translation and scientific communication)
- Funding People (see above)
- Funding Infrastructure

For characterising the agencies, we will stick however to the less abstract version of Table 1. To assess the individual funding schemes, we use the general information available on the websites of the agencies as well as the detailed guidelines for application, aimed at researchers who want to apply to specific funding schemes. We also systematically describe other features of the agencies, which may (indirectly) be important in affecting the impact of funds on the rate and direction of research. We follow this common structure:

Table 4: Structure of agencies - characterisation with main distinctive features

Section	**What we look out for**
1. Organisational mission and structure	
Mission focus	• Mission focus more narrowly on funding basic/academic research or more broadly also on o funding dissemination of knowledge, use of research results o creating economic and societal impacts o education, training and career development
Overarching decision structures	Role of scientific community in i) general/strategic decision making and in ii) individual funding decisions through participation in reviews, i.e. are funds self-governed by academics or are they professional governmental agencies, do scientists have a formal say in funding policies decisions or do they just have an advisory role
Allocation of government funding to agency	Who decides on budget of agencies, mechanisms for budget approval; existence of a multi-annual spending framework
Organisation of funding activities	How agencies operate, unit of funding at the operational level
2. Overview of funding schemes	In a table, • Name of funding scheme according to the fund • Classification of schemes according to the structure proposed by study authors • Description of funding scheme • Funding scheme is discipline-specific or open to all disciplines • Research topic origin: Proposal topic is investigator-initiated ("bottom-up") or proposed by science fund ("top-down") • Subject of funding scheme ("Who gets funded")
3. (Quantitative) Characteristics of funding schemes	In graphs, • Share of schemes in total funding • Share of disciplines in total funding In a table, conditional on available data, • Share of scheme in total funding • Lot size • Duration of funding • Success rates
4. Refundable costs and review procedures of (selected) funding schemes	• In particular, if principal investigators' salary can be funded by the grant and if/how indirect costs ("overhead") are being reimbursed • Quality and nature of peer review process (selection of reviewers, organization of review (mail, panel, etc.), criteria

Section	What we look out for
	for review (weight between different criteria, e.g. track record of applicant vs quality of proposal, potential impact etc.), rights of applicants

5. Important changes over time	• Changes at the level of the agency
	  o Changes in organisational structure
	  o Changes in overall funding levels
	• Changes at the level of the individual funding schemes
	  o Shifts in budget shares between schemes
	  o Closure of funding schemes, introduction of new funding schemes
	• Structural changes in allocation of funding (e.g. review procedures, overhead costs, etc.)

6. Information and data sources	List of main sources, contacts at agencies

The following data series are currently available for the agencies (not all the information is present for all the various funding schemes though, see section 1):

- 1997-2017: DFG, FWF, SNSF, NSF
- 1998-2017: NIH
- 2000-2016: NWO (aggregate level); 2005-2010, 2015/16: NWO (more detailed, at funding scheme level)
- 2006-2017: UK Research Councils database (with incomplete information though); yearly reports of individual Research Councils differ from MRC (2000-2017[1]) to BBSRC/ESRC (2011-2017), see section 3 on UKRI

Note that for reasons of international comparability, we use four broad disciplines to present available information on funding by discipline: natural sciences (including biological and agricultural sciences, as well as veterinary medicine), medicine, engineering and social sciences&humanities. Some agencies are able to provide funding information on a more disaggregated level.

[1] The MRC data differs from other councils because whereas most councils included awards made from 2006, the MRC included all awards active from 2006.

3.2 Deutsche Forschungsgemeinschaft (DFG, German Research Foundation, Germany)

3.2.1 Organisational mission and structure

Mission focus

The DFG is more narrowly focused on funding scientific research and does not emphasise strongly the potential impacts of this research ("the DFG funds excellent science without regard to extra-scientific factors").

The following information was taken from the DFG website:

Best Projects

The main task of the DFG is to select the best projects by researchers at universities and research institutions on a competitive basis and to finance these projects. Individuals or higher education institutions submit proposals in a particular field of curiosity-driven basic research that they themselves select. Interdisciplinary proposals are also considered.

Early career support

The DFG awards the best researchers with funding and, at the same time, gives them the means and freedom necessary for successful research. One of the DFG's key objectives is the advancement of early career researchers. It therefore offers them programmes which provide appropriate support at every phase of their qualification. The DFG is especially committed to the early independence of researchers and supports the recruitment of talented scientists and academics from at home and abroad for German research.

The DFG funds excellent science without regard to extra-scientific factors. Equal treatment of men and women and broad representation of the scientific disciplines in the self-governance of the DFG ensure the diversity and originality required for outstanding research.

Interdisciplinary cooperation

The DFG supports projects from all areas of science and the humanities and especially promotes interdisciplinary cooperation among researchers. DFG funding enables cooperation between researchers from all branches of science as well as the formation of internationally visible priorities at universities and non-university research institutions.

Policy advice

The DFG provides scientific policy advice. As the voice of science in political and social discourse, it counsels and participates in political decision-making processes with scientific expertise. With the deliberations of its Senate commissions and the publication of their findings, the DFG makes recommendations concerning fundamental issues in science and concerning the responsible application of scientific findings in society.

Source: http://www.dfg.de/en/dfg_profile/mission/index.html.

Overarching decision structures

The DFG shows features of academic self-governance, i.e. German academics have a formal say in establishing general principles of the agency's operation.

The legal status of the DFG is that of an association under private law. As such, the DFG can only act through its statutory bodies, in particular through its Executive Board and the General Assembly (http://www.dfg.de/en/dfg_profile/statutory_bodies/index.jsp). Other important bodies are the Senate, the Joint Committee, the Executive Committee, the Head Office and the 48 Review Boards.

The **Executive Board** is responsible for the DFG's regular business. It consists of the President, responsible for internal and external representation and the Secretary General who runs the head office.

Organisational chart: http://www.dfg.de/en/dfg_profile/head_office/structure/organisational_chart/index.jsp?id=0#content.

- General/strategic decision making

The **General Assembly** determines the principles of the DFG's work. It is made up of research universities, major research institutions of general importance, academies of sciences and humanities as well as a number of scientific associations.

The **Executive Committee** consists of the President, the Vice Presidents (eight at present) and the President of the Donors' Association, who serves in an advisory capacity. Their main aim is to develop the strategic and conceptual direction of the DFG.

The Senate has 39 members from the scientific and academic communities and is therefore responsible for all important decisions relating to research funding prior to the final funding decision and for all important decisions relating to organising the review, assessment and decision-making processes.

- Decision structures for funding

The **Joint Committee** is responsible for the financial support for research provided by the DFG. It is the DFG's main decision-making body. It bases its final research-policy decisions that relate to the DFG on resolutions passed by the Senate. The Joint Committee is made up of 39 members of the Senate, representatives from the federal government (with a total of 16 votes), 16 representatives from the federal states and 2 representatives from the Donors' Association for the Promotion of Sciences and the Humanities in Germany.

The **Head Office** supports the work of the bodies and administers the DFG funding programmes.

The main task of the **review boards** is to provide quality assurance for the review process as part of the preparation for DFG funding decisions. Members of the review boards are elected by researchers for four years in accordance with election regulations to be adopted by the Senate. They are assigned to a subject area according to the focus of their own research work.

Source: http://www.dfg.de/en/dfg_profile/statutory_bodies/executive_committee/index.html.

Allocation of government funding to agency

The DFG receives two thirds of its grants from the Federal Government and one third from the Länder (Germany's regions or states), the total amount of institutional and project funding being calculated according to the "Königsteiner Schlüssel", a formula used in Germany to distribute funds between the federal and the state level. The proposal for the funding budget, including the administrative budget, is prepared by the DFG Head Office; the proposal is adopted by the Joint Committee, the DFG's decision-making body consisting of researchers and representatives of the Federal Government and the Länder. The final decision on the DFG's funding and administrative budget rests with the GWK (Gemeinsame Wissenschaftskonferenz or Joint Science Conference), the joint body of science and finance ministers of the Federal Government and the Länder. In the GWK, the Federal Government has 16 votes and the 16 Länder one vote each. In principle, the GWK passes its resolutions with a majority of 29 votes. The Pact for Research and Innovation (2016-2020) resulted in an annual increase in the DFG budget of three percent over that period. There is hence no real multi-annual spending framework for the DFG, but it can profit from multi-annual higher-level strategies.

Source: Information sent by the DFG.

Organisation of funding activities

The DFG allocates money through various funding schemes (see table below) which are in general not discipline-specific (Review Boards and the Head Office are structured by scientific disciplines though). To arrive at a budget across all disciplines, the number of applications and the number of proposals granted in the past is used. According to the DFG, there are tools available to react in the case of discipline-specific under- or over-shooting of requests for funding.

Source: Assessment by study authors.

3.2.2 Overview of funding schemes

The following information is taken from the DFG website. Research topic origin: Proposal topic is investigator-initiated ("bottom-up") or proposed by science fund ("top-down")

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Individual Grants Programmes	Research Grants	Single project funding	no	bottom-up	Project	Research grants enable individuals who have completed their academic training to conduct at any time research projects with clearly defined topics and durations, regardless of the subject.	http://www.dfg.de/en/research_funding/programmes/individual/research_grants/index.html
	Scientific Networks	Networks and Multi-Project funding	no	bottom-up	Project	Scientific networks offer early career researchers the opportunity to engage in scientific exchange and cooperation on topics of common interest across locations.	http://www.dfg.de/en/research_funding/programmes/individual/scientific_networks/index.html
	Research Fellowships	Mobility	no	N/A	Person	Research Fellowships are intended to help early career researchers to conduct a defined project at a location of their choice in a country other than Germany and to use it as an opportunity to familiarise themselves with new research methods or to bring a large project to a conclusion.	http://www.dfg.de/en/research_funding/programmes/individual/research_fellowships/index.html
	Emmy Noether-Programm	Career	no	N/A	Person	The Emmy Noether Programme gives exceptionally qualified early career researchers the chance to qualify for the post of professor at a university by leading an independent junior research group for a period of six years. The programme is open to postdocs and junior professors with temporary contracts who are at an early stage in their research careers.	http://www.dfg.de/en/research_funding/programmes/individual/emmy_noether/index.html
	Heisenberg-Programm	Career	no	bottom-up	Person	If you already meet all the requirements for appointment to a permanent professorship, you can apply to the Heisenberg Programme. While you prepare for a future senior academic role, the DFG provides funding to enable you to carry on with high-quality research at the institution of your choice and continue building your academic reputation.	http://www.dfg.de/en/research_funding/programmes/individual/heisenberg/index.html
	Reinhart Koselleck-Projects	SPF high-risk	no	bottom-up	Project	This programme enables outstanding researchers with a proven scientific track record to pursue exceptionally innovative, higher-risk projects.	http://www.dfg.de/en/research_funding/programmes/individual/reinhart_koselleck_projects/index.html
	Clinical Trials	Applied Research	no	bottom-up	Project	The Clinical Trials Programme enables individuals who have completed their academic training to conduct at any time patient-oriented clinical research within a temporary project. The programme provides funding for interventional clinical studies, including feasibility studies (phase II) and interventional trials (phase III). The programme also funds observational trials, provided that the study investigates a highly relevant research question that cannot demonstrably be answered using an interventional design.	http://www.dfg.de/en/research_funding/programmes/individual/clinical_trials/index.html

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
	Workshops for Early Career Investigators	Career	no	N/A	Person	Workshops for early career investigators are a strategic funding instrument. These are aimed particularly at established researchers seeking to address a perceived lack of early-career researchers in their field by holding workshops for early career investigators on specific topics.	http://www.dfg.de/en/research_funding/programmes/individual/workshops_early_career_investigators/index.html
	Project Academies	Diversification	no	bottom-up	Person	The aim of project academies is to enable professors from universities of applied sciences to engage in research projects based on DFG third-party funding at an early stage in their careers.	http://www.dfg.de/en/research_funding/programmes/individual/project_academy/index.html
Coordinated Programmes	Priority Programmes	Thematic priority area, but also interdisciplinary and multi-location; the thematic focus is not mission-oriented (in terms of addressing societal problems) but scientific (in terms of fostering emerging fields)	yes	top-down	Project	As a rule, Priority Programmes receive funding for a period of six years. If researchers are interested in collaborating on a Priority Programme, the DFG will invite them to submit the corresponding applications for research grants by a certain deadline.	http://www.dfg.de/en/research_funding/programmes/coordinated_programmes/index.html
	Collaborative Research Centres	Structural priority area	no	bottom-up	Project	Collaborative Research Centres are long-term university-based research institutions, established for up to 12 years, in which researchers work together within a multidisciplinary research programme.	http://www.dfg.de/en/research_funding/programmes/coordinated_programmes/priority_programmes/index.html
	Research Training Groups	Education & Training	no	bottom-up	Institution	Research Training Groups are established by universities to promote young researchers. They are funded by the DFG for a period of up to nine years. Their key emphasis is on the qualification of doctoral researchers within the framework of a focused research programme and a structured training strategy. Research Training Groups with an interdisciplinary approach are warmly welcomed.	http://www.dfg.de/en/research_funding/programmes/coordinated_programmes/research_training_groups/index.html
	DFG Research Centres	Structural priority area	no	top-down	Institution	The primary objective of this programme is to establish a limited number of internationally visible and competitive research centres at German universities.	http://www.dfg.de/en/research_funding/programmes/coordinated_programmes/research_centres/index.html
	Research Units	Networks and Multi-Project funding	no	bottom-up	Project	A Research Unit is made up of a team of researchers working together on a research project which, in terms of thematic focus, duration and finances, extends beyond the funding options available under the Individual Grants Programme or Priority Programme.	http://www.dfg.de/en/research_funding/programmes/coordinated_programmes/research_units/index.html

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
	Clinical Research Units	Networks and Multi-Project funding	yes	bottom-up	Project	Clinical Research Units provide outstanding researchers the opportunity to carry out close, medium-term cooperation in a special research project from the field of disease or patient-oriented clinical research.	http://www.dfg.de/en/research_funding/programmes/coordinated_programmes/clinical_research_units/index.html
	Centres for Advanced Studies in the Humanities and Social Sciences	Networks and Multi-Project funding	yes	bottom-up	Project	The key characteristics of Centres for Advanced Studies in the Humanities and Social Sciences are - intensive independent research performed by the researchers responsible – where applicable, made possible through leave of absence - a fellow programme for visiting researchers from Germany and abroad; these visiting researchers are to be invited for periods of up to two years and will maintain links with the Humanities Centres for Advanced Studies once their visit is over - the integration of early career researchers	http://www.dfg.de/en/research_funding/programmes/coordinated_programmes/humanities_centres/index.html
Excellence Strategy	Excellence Strategy	Structural priority area	no	bottom-up	Institution	The aim of the Excellence Strategy is to strengthen Germany's position as an outstanding place for research in the long term and further improve its international competitiveness.	http://www.dfg.de/en/research_funding/programmes/excellence_strategy/index.html
Research Infrastructure	Scientific Instrumentation and Information Technology	Infrastructure	no	bottom-up	Project	Scientific instrumentation and equipment can be applied for in several of the DFG's funding programmes.	http://www.dfg.de/foerderung/programme/Infrastructure/index.html
	Scientific Library Services and Information Systems (LIS)	Infrastructure	no	bottom-up	Project	As part of the Scientific Library Services and Information Systems programme the DFG funds projects at libraries, archives and other scientific service and information centres in Germany. The aim is to set up nationwide efficient research information systems.	
Scientific Prizes	Gottfried Wilhelm Leibniz Prize	Prizes	no	N/A	Person	The Gottfried Wilhelm Leibniz Programme awards prizes to exceptional scientists and academics for their outstanding achievements in the field of research.	http://www.dfg.de/foerderung/programme/Prizes/index.html
	Heinz Maier-Leibnitz Prize	Prizes	no	N/A	Person	The Heinz Maier-Leibnitz Prize, named after the physicist and former president of the DFG, is a distinction for young researchers and provides further incentive for excellent achievements in their research work.	http://www.dfg.de/foerderung/programme/Prizes/index.html
	Communicator Award	Prizes	no	N/A	Person	The "Communicator Award – Science Award of the Donors' Association" is awarded by the DFG. This personal award, worth €50,000, is given to researchers who have communicated their scientific findings to the public with exceptional success.	http://www.dfg.de/foerderung/programme/Prizes/index.html

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
	von Kaven Award	Prizes	yes	N/A	Person	The von Kaven Award is presented each year to an outstanding EU-based mathematician.	http://www.dfg.de/foerderung/programme/Prizes/index.html
	Bernd Rendel Prize	Prizes	yes	N/A	Person	The Bernd Rendel Prize is awarded annually by the DFG to qualified early career geoscientists who do not yet hold a doctorate. Criteria for the selection of awardees are quality and originality of the research as well as the scientific potential of the candidates.	http://www.dfg.de/foerderung/programme/Prizes/index.html
	Ursula M. Händel Prize	Prizes	no	N/A	Person	The Ursula M. Händel-Prize recognises scientists who have made exemplary and sustained efforts to improve the welfare of animals in research.	http://www.dfg.de/foerderung/programme/Prizes/index.html
	Copernicus Award	Prizes	no	N/A	Person	The Copernicus Award is conferred every two years to two researchers, one in Germany and one in Poland, for outstanding achievements in German-Polish scientific cooperation. It is conferred jointly by the DFG and the Foundation for Polish Science (Fundacyes na rzecz Nauki Polskiej, FNP).	http://www.dfg.de/foerderung/programme/Prizes/index.html
	Eugen and Ilse Seibold Prize	Prizes	yes	N/A	Person	The Eugen and Ilse Seibold Prize, donated by the marine geologist and former president of the DFG and his wife, serves to promote research and understanding between Germany and Japan.	http://www.dfg.de/foerderung/programme/Prizes/index.html
	Albert Maucher Prize in Geoscience	Prizes	yes	N/A	Person	The Albert Maucher Prize in Geoscience is awarded once every three years to early career researchers in recognition of outstanding research findings and original approaches. Researchers who already have a full professorship cannot be nominated.	http://www.dfg.de/foerderung/programme/Prizes/index.html
International Programmes	Initiation of International Collaboration	International Cooperation	no	N/A	Person	Applicants interested in establishing collaborative scientific relationships with partners abroad may apply for funding for trips abroad, guest visits or for exploratory workshops.	http://www.dfg.de/en/research_funding/programmes/international_cooperation/initiation_international_collaboration/index.html
	International Scientific Events	Mobility	no	bottom-up	Project	The DFG provides funding to conduct scientific events in Germany.	http://www.dfg.de/en/research_funding/programmes/international_cooperation/international_events/index.html
	Mercator Fellows	Networks and Multi-Project funding	no	bottom-up	Person	As part of the modularisation of the DFG's funding programmes, a Mercator Fellow module has been developed. The current Mercator Programme has been incorporated into this module.	http://www.dfg.de/en/research_funding/programmes/international_cooperation/mercator_fellows/index.html

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
	Joint Proposal Submission with Austria and Switzerland (D-A-CH)	International Cooperation	no	bottom-up	Project	Proposal Submission in the Lead Agency process for cross-border research projects.	http://www.dfg.de/en/research_funding/programmes/international_cooperation/joint_proposal_submission_dach/index.html
	Joint Proposal Submission with Luxembourg (D-LUX)	International Cooperation	no	bottom-up	Project	Proposal Submission in the Lead Agency process for cross-border research projects.	http://www.dfg.de/en/research_funding/programmes/international_cooperation/joint_proposal_luxembourg/index.html
	Cooperation with Developing Countries	International Cooperation	no	bottom-up	Project	The DFG enables research cooperations between researchers in Germany and in developing countries through research grants for individual projects.	http://www.dfg.de/en/research_funding/programmes/international_cooperation/developing_countries/index.html
	Middle East Collaboration	International Cooperation	no	bottom-up	Project	Within the framework of individual grants, the DFG supports German-Israeli collaborative projects, sometimes involving additional partners from Palestine or from Israel's neighbouring countries (Egypt, Jordan, Lebanon, Syria).	http://www.dfg.de/en/research_funding/programmes/international_cooperation/middle_east_collaboration/index.html
	German-Israeli Project Cooperation	International Cooperation	no	bottom-up	Project	Under this programme of excellence, launched by the German Federal Ministry for Education and Research (BMBF) in 1997, the six leading universities in Israel and the Weizmann Institute of Science are each eligible to submit two project proposals each year.	http://www.dfg.de/en/research_funding/programmes/international_cooperation/german_israeli_cooperation/index.html
	Max Kade Foundation Fellowship Programme	Mobility	yes	NA	Person	In addition to numerous international funding instruments, the DFG also supports the Max-Kade-Foundation with their selection of applicants for a fellowship program.	http://www.dfg.de/en/research_funding/programmes/international_cooperation/max_kade/index.html

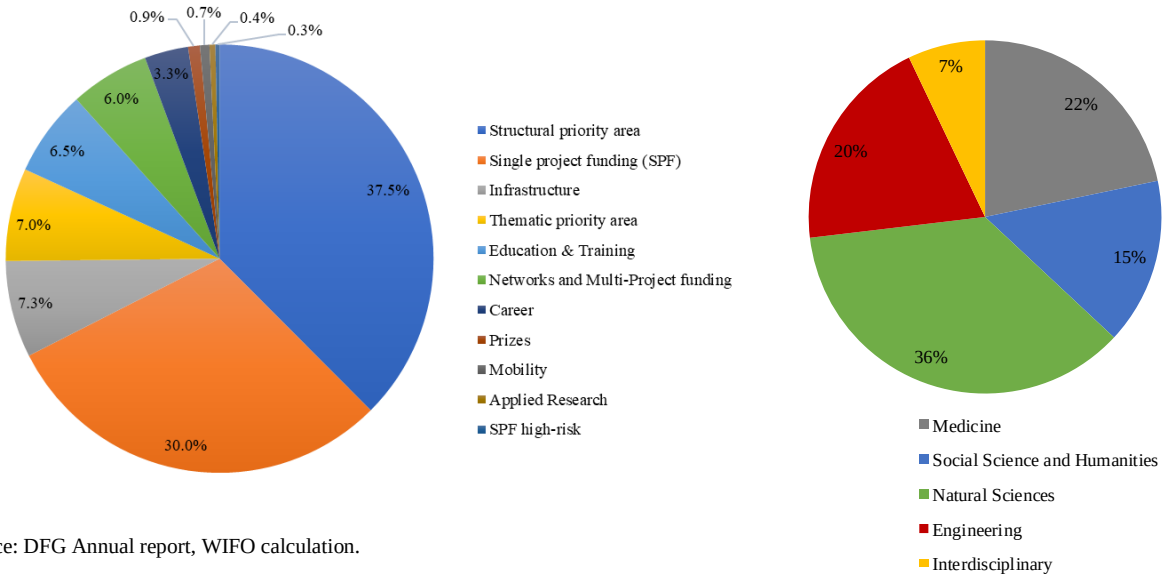
Source: Content of funding schemes: http://www.dfg.de/foerderung/programme/index.html, application documents of funding schemes. Bottom-up/top-down is assessment by WIFO based on the online description of the funding schemes and the application documents.

3.2.3 Characteristics of funding schemes

Funding of the creation of knowledge in the broadest sense (structural priority areas, single project funding and networks/multi-project funding) dominate the funding portfolio. In particular structural priority funding is high (see section 4). Thematic focus, in particular with regard to addressing challenges, rather than emerging fields, achieves only a small share, just as translational schemes which are limited to clinical trials. However, funding translation of basic research proposals is possible in the research grant schemes individual research grants, priority programmes and research units, as a follow-up of basic research (http://www.dfg.de/formulare/54_014/54_014_en.pdf). High-risk and career-oriented funding schemes achieve only a small share of the total, note however that the support of young researchers can also be an aim of funding schemes classified in other scheme types, such as Collaborative Research Centres, and that the main single project funding scheme specifies review criteria for first-time applicants (see below). Note that the DFG does not show dedicated interdisciplinary funding schemes, however interdisciplinarity is a criterion in several funding schemes, such as the Research Training Groups or the Collaborative Research Centres.

Natural sciences achieve the highest share in overall funding, followed at some distance by medicine and engineering, social sciences & humanities as well as interdisciplinary research. Note that the DFG can provide more detailed information on funding by discipline, by e.g. showing also life sciences as a separate subcategory. For reasons of international comparability, we present however only the broad split in figure 1 below.

Figure 1: DFG total awarded funding according to study author classification (left panel) and share of disciplines in total awarded funding (right panel), 2017



Source: DFG Annual report, WIFO calculation.

Table 5: Selected characteristics of the funding schemes, 2017

Funding scheme according to study scheme classification	Original fund name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success rate
Total	-	**100%**	**N/A**	**N/A**	**N/A**	**N/A**	**30%**
Project funding	-	**37%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Single project funding (SPF)	Research Grants	30%	N/A	0.28	3 Years	N/A	30%
SPF Early career	-	-	-	-	-	-	-
SPF high-risk	Reinhart Koselleck-Projects	0.3%	0.5-1.2 Mio. EUR	0.20	5 Years	N/A	N/A
Networks and Multi-Project funding	-	6%	N/A	0.06	N/A	N/A	N/A
	Research Units	5%	N/A	0.08	6 Years	N/A	N/A
	International scientific contacts	0.7%	30-300 EUR	0.02	N/A	N/A	N/A
Interdisciplinary research	-	-	-	-	-	-	-
Priority areas	-	**45%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Structural priority area	-	38%	N/A	0.21	N/A	N/A	N/A
	Collaborative Research Centres	23%	N/A	0.13	N/A	N/A	N/A
	DFG Research Centres	0.8%	5 Mio. EUR annually	6.65	N/A	N/A	N/A
	Excellence Strategy	14%	3-10 Mio. EUR annually	4.43	7 Years	N/A	N/A
Thematic priority area	Priority programmes	7%	N/A	0.06	6 Years	N/A	N/A
Infrastructure	**Research Infrastructure**	**7%**	**50% of acquisition value, max. 5 Mio. EUR**	**0.25**	**N/A**	**N/A**	**N/A**
Funding of people	-	**11%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Education & Training	Research Training Groups	7%	N/A	0.08	4.5 Years	N/A	N/A
Career		3.3%	N/A	N/A	N/A	N/A	N/A
	Emmy Noether programme	2.5%	N/A	0.23	6 Years	N/A	N/A
	Heisenberg-Programme	0.8%	N/A	0.06	5 Years	N/A	N/A
Diversification	-	-	-	-	-	-	-
Prizes	Scientific Prizes	1%	1,500 EUR-2.5 Mio. EUR	0.29	N/A	N/A	N/A
Mobility	Research Fellowships	0.7%	2,000 EUR/ month	0.02	2 Years	N/A	N/A
International Cooperation	-	-	-	-	-	-	-
Translation	-	**0.4%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Applied Research	Clinical trials	0.4%	0.35 Mio. EUR	0.33	3 Years	N/A	N/A
R&D Collaboration with firms	-	-	-	-	-	-	-
Commercialisation	-	-	-	-	-	-	-

Funding scheme according to study scheme classification	Original fund name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success rate
R&D Value Chain	-	-	-	-	-	-	-
Scientific Communication	-	-	-	-	-	-	-

Source: Application documents for Lot size and Project duration, Annual Reports for Success rates, information provided by the DFG. Note: Lot size is the size of the total grant (the total amount of money granted for the researcher's proposal) which will usually be consumed over a period of several years (funding duration). Lot size according to application documents is the maximum amount of money researchers can ask for (or the minimum-maximum range); Lot size statistical is the actual average amount of money paid out for granted projects. Success rates are the share of granted applications relative to the total number of full applications. Minor deviations due to rounding. A "-"-sign indicates that data/the scheme do not exist at all; N/A indicates that an assessment category is not applicable to the individual funding scheme, or that data are not available. * calculated by WIFO; note that the low statistical figure for Research Grants (Sachbeihilfen) includes various items paid out under the Research Grants, such as help for publication costs, which will only amount to a couple of thousand Euros.

Concerning the funding duration, note that Research Grants are renewable using the same review process, but achieving much higher success rates (63% according to the DFG). Within funding schemes such as single project funding, there are further subdivisions, e.g. for long-term research projects up to 12 years. No separate data are available for them (see http://www.dfg.de/foerderung/programme/einzelfoerderung/sachbeihilfe/formulare_merkblaetter/index.jsp).

The funding rate for renewal applications is significantly higher than for new applications: In 2017, 63% of renewal proposals and 36% of new proposals were approved.

3.2.4 Refundable costs and review procedures of single project funding

The following costs will be refunded:

- Wages of scientific/ technical staff
- Material expenses (i.e. Costs for equipment and materials of permanent value, direct costs for the use of infrastructures (including costs for maintenance and care), consumables, field expenses, computing time and data (cloud computing), costs for making research data accessible (open research data).
- Mobility (Travel (incl. accommodation and catering costs), conferences and workshops.
- Third-party expenses (Costs of project partners (not wages), consulting, consortia, outsourcing through subcontracting)
- Costs of scientific (open access) publications.
- Administrative costs

Salaries of the principal investigator cannot be refunded (except for career and mobility programmes, Research Fellowships, Heisenberg-Programme or "Eigene Stelle" (a specific module of the Research Grants, called "Temporary Positions for Principal Investigators", which provides a post-doc salary for non-tenured principal investigators, so that they can fund their own position). Moreover, again as a module ("Replacement") in the Research Grants scheme, researchers can apply for funds to buy them out of their teaching and administrative duties, i.e. for funds for a qualified person to replace them for a period of max. 12 months, up to the salary of the applicant. The need has to be justified though and the research institution hosting the researcher needs to agree.

- Indirect cost rate (*Programmpauschale*, overheads): 22%

The indirect costs remain with the research institution, not with the researcher and can be used freely by the research institution, e.g. also strategically to fund new research.

Source: http://www.dfg.de/formulare/1_19/1_19_de.pdf, http://www.dfg.de/formulare/2_023/2_023_de.pdf.

Table 6: Overview of review process for individual research grants ("Sachbeihilfen")
The following information is taken from the DFG website:

Internal/External reviewers:	External reviewers
Number of reviewers (per proposal):	N/A
International/National reviewers:	both
Organisation of Review:	**1st stage mail review** by external peer reviewers; **2nd stage Review board** (external researchers nominated for four years; elected by scientists and academics) examines the reviews, gives funding recommendation to **Joint Committee** which decides (also based on interdisciplinary comparison)
Assessment criteria (incl. weights or relative importance, if available):	**General assessment criteria** • scientific quality of the project (originality and anticipated contribution to knowledge) • Objectives and work programme (feasibility – clear working hypotheses, suitability of method and appropriateness of schedule) • *applicants' qualifications (*soundness of the preliminary work, the quality of publications) • Work and research environment (at the institution where the project is to be carried out) • Appropriateness of funding requested relative to research proposed • No weights given. There are special criteria for **first-time applicants**, where potential and the quality of the proposal matter more than the track record (past publications) for coordinated programmes: quality and added value of cooperation programme-specific criteria

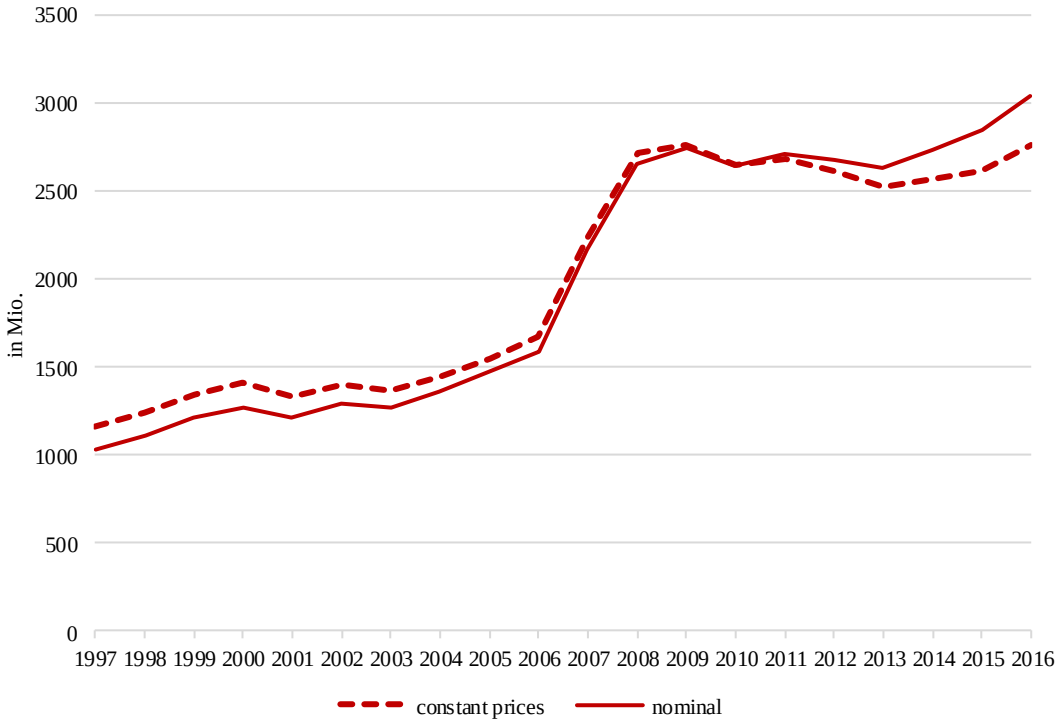
Source: http://www.dfg.de/download/pdf/foerderung/antragstellung/begutachtung/dfg_begutachtungsverfahren_130715_en.pdf, http://www.dfg.de/en/research_funding/proposal_review_decision/reviewers/index.html, http://www.dfg.de/formulare/10_20/10_20_en.pdf, http://www.dfg.de/formulare/10_206/10_206_en.pdf.

3.2.5 Important changes over time

Changes at the level of the agency

- Changes in organisational structure: N/A
- Changes in overall funding levels: The funding awarded by the DFG doubled since 2002, there has been a particularly steep increase between the years 2006-2008

Figure 2: DFG funding awarded in current and constant EUR, 1997-2016

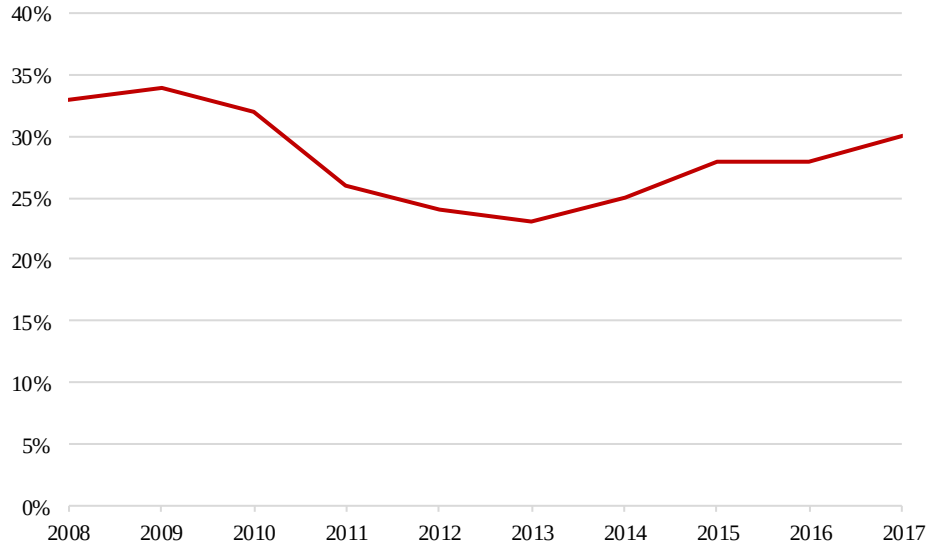


Source: DFG Annual reports, AMECO database for BIP deflator (2010=100), WIFO calculation.

Changes at the level of the individual funding schemes

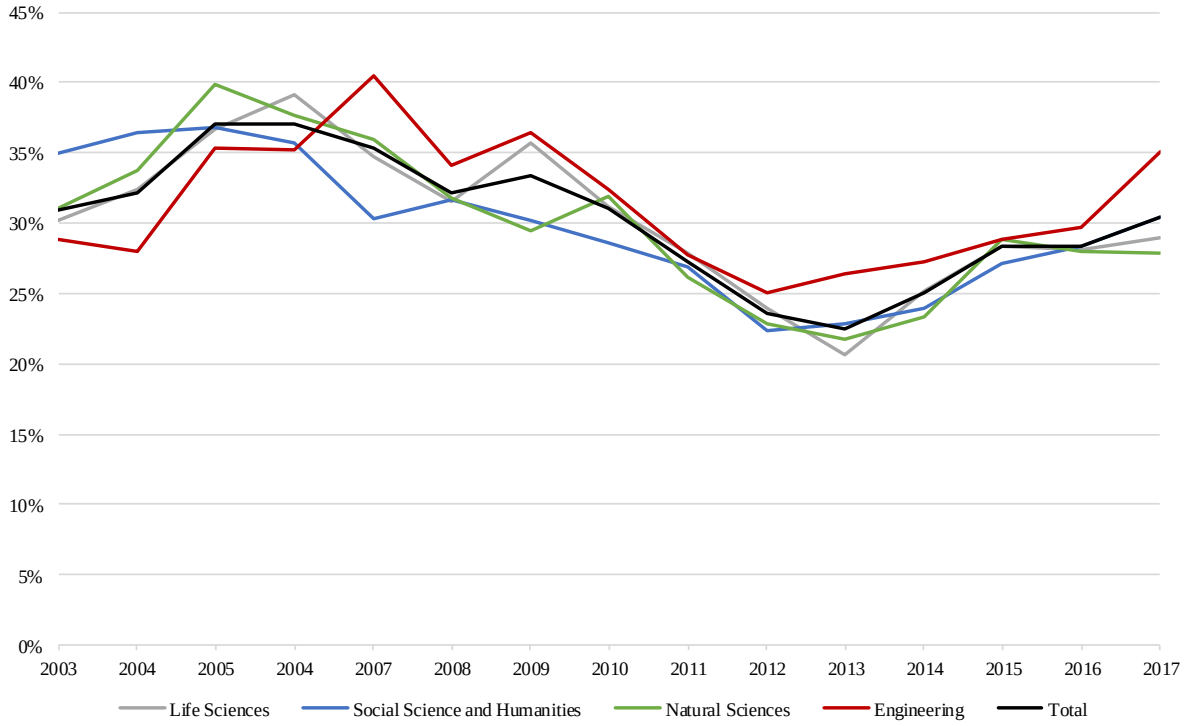
- The success rate in single project funding fluctuated between close to 35% in 2009 down to 23-24% in 2013 but has since then recovered to 30%.

Figure 3: Success rate in Single project funding, 2008-2017



Source: DFG data, calculation ISI-Fraunhofer.

Figure 4:DFG Success Rates in Single project funding by scientific disciplines, 2003-2017



Source: DFG Annual reports. Note: Single project funding in this graph comprises more programmes than the programme “Sachbeihilfe”, which has been used for all other calculations.

The success rate by disciplines is as follows: humanities and social sciences: 35.7%, life sciences: 32.4%, natural sciences: 37.3%, engineering sciences: 41.0%). An overview of the development of funding rates in the (somewhat broader) individual funding areas, broken down by scientific discipline, can be found in the DFG Annual Reports and at http://www.dfg.de/en/dfg_profile/facts_figures/index.html.

  - 2011-2013: Strong increase in applications for individual funding combined with a decline in funding quotas.

- Shifts in budget shares between schemes

The funding portfolio of the DFG has evolved considerably over the past 20 years, seeing a marked increase of the share of structural priority funding (not least due to the introduction of the "excellence initiative"). Infrastructure funding has also increased, followed by people's funding, whereas the share of project funding has clearly decreased, by contrast.

Table 7: DFG shares of funding instruments, change in percentage points between 1997-2017

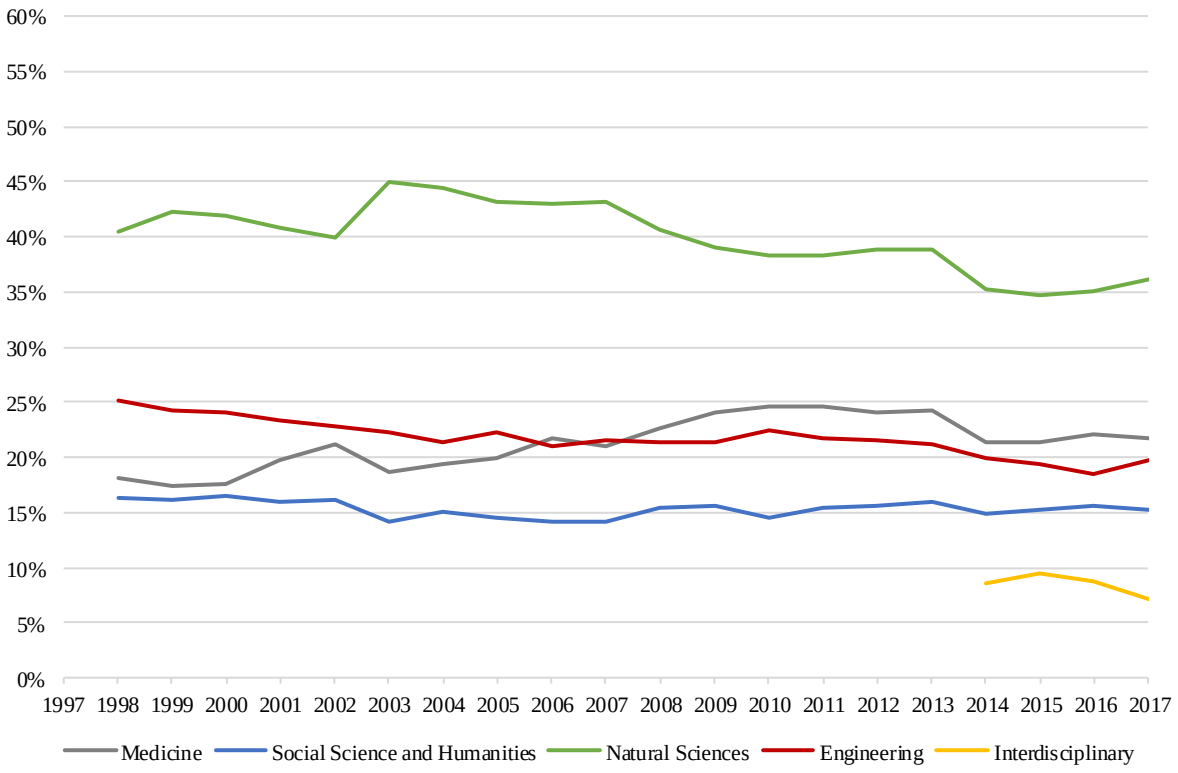
	Share in 2017	**Change of share 1997-2017 in percentage points**
Project funding	**36.3%**	**-7.0**
Single project funding (SPF)	30.0%	-8.4
SPF Early career	-	-
SPF high-risk	0.3%	+0.3
Networks and Multi-Project funding	6.0%	+1.2
Interdisciplinary research	-	-
Priority areas	**44.5%**	**+3.4**
Structural priority area	37.5%	+10.3
Thematic priority area	7.0%	-6.8
Infrastructure	**7.3%**	**+4.6**
Funding of people	**10.6%**	**+1.4**
Education & Training	6.5%	+0.7
Career	3.3%	+2.1
Diversification	N/A	N/A
Prizes	0.9%	-2.5
Mobility	0.7%	+0.7
International Cooperation	**N/A**	**N/A**
Translation	**0.4%**	**+0.4**

Applied Research	0.4%	+0.4
R&D Collaboration with firms	-	-
Commercialisation	-	-
R&D Value Chain	-	-
Scientific Communication	-	-

Source: DFG Annual report, WIFO calculation.

The share of disciplines in total funding has kept quite stable with the exception of natural sciences, with a decline in all disciplines in the most recent years with the exception of social sciences & humanities, due to the introduction of the category "interdisciplinary". Natural Sciences lose most, from highs of over 50% to 35% in the most recent year. Engineering declines from 25% to 20% and is overtaken by medicine, which increases from 18% to 22%.

Figure 5: Total awarded funding in Single project funding and coordinated programs by discipline - Germany, 1998-2017



Source: Annual DFG reports, WIFO calculation. Note: No split by disciplines available, only for SPF.

- Closure of funding schemes, introduction of new funding schemes:

The most important novelty in the funding portfolio was the introduction of the "Exzellenzinitiative" since 2005, to bolster German universities' international standing. As German universities are financed by the Länder (the

regions), the federal level can only use federal-level instruments such as the DFG to incentivise structural reforms among universities.

Structural changes in allocation of funding (e.g. review procedures, overhead costs, etc.)

- Introduction of indirect cost rate "Programmpauschale" (Flat-rate programme allowance) - Gradual introduction from 2008, increase from 20% to 22% from 2016 onwards.
- Limitation of number of publications to be included with research proposal to 5 for general CV and 2 related to proposal
- Since 2011: Conversion to "money instead of position": Instead of a detailed specification of which researchers are going to be involved in the project, money will now be granted for job categories, which the recipients will then manage themselves.

3.2.6 Information and data sources

Contact at fund

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Press and Public Relations Office

michael.hoenscheid@dfg.de

William Dinkel

Director Information Management

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Annual reports

1997-2015: PDF copies sent by DFG

2016-2017: online see http://www.dfg.de/en/dfg_profile/annual_report/

Information about structure of fund

http://www.dfg.de/dfg_profil/aufgaben/index.html

http://www.dfg.de/en/dfg_profile/mission/index.html

http://www.dfg.de/en/dfg_profile/head_office/structure/organisational_chart/index.jsp?id=0#content

Information about application and review procedures

http://www.dfg.de/foerderung/antrag_gutachter_gremien/quo_vadis_antrag/index.html

http://www.dfg.de/foerderung/antrag_gutachter_gremien/antragstellende/index.html

Refundable costs for 2018

http://www.dfg.de/formulare/60_12/60_12_de.pdf

http://www.dfg.de/formulare/1_19/1_19_de.pdf

http://www.dfg.de/formulare/10_20/10_20_de.pdf

3.3 The Austrian Science Fund (FWF)

3.3.1 Organisational mission and structure

Mission

The FWF focuses mainly on funding science also with a view to the competitiveness of Austria's research institutions, as well as on developing human resources for science. The non-scientific use of the research funded as well as the impact on the economy and society are mentioned by way of "interactive effects". The following information is taken from the FWF website:

The Austrian Science Fund (FWF) is Austria's central funding organization for basic research. The purpose of the FWF is to support the ongoing development of Austrian science and basic research at a high international level. In this way, the FWF makes a significant contribution to cultural development, to the advancement of our knowledge-based society, and thus to the creation of value and wealth in Austria.

FWF's objectives are:

- To strengthen Austria's international performance and capabilities in science and research as well as the country's attractiveness as a location for high-level scientific activities, primarily by funding top-quality research projects for individuals and teams and by enhancing the competitiveness of Austria's innovation system and its research facilities;
- To develop Austria's human resources for science and research in both qualitative and quantitative terms based on the principle of research-driven education;
- To emphasize and enhance the interactive effects of science and research with all other areas of culture, the economy and society, and in particular to increase the acceptance of science and research through concerted public relations activities.

Source: https://www.fwf.ac.at/en/about-the-fwf/corporate-policy/.

Overarching decision structures

The FWF has features of academic self-governance, in that external academics have a formal say in the decision structures of the FWF.

Organisational chart: https://www.fwf.ac.at/en/about-the-fwf/organisation/fwf-team/organisational-chart/.

- General/strategic decision making

Composed of the President, three Scientific Vice-Presidents and the Executive Vice-President, the **Executive Board** coordinates the organisation's activities and is in charge of defining the FWF's strategic objectives as well as developing and furthering its funding programmes. In addition, the Executive Board takes part in negotiations with Austrian and European research policymakers, cooperates with universities and other scientific institutions in Austria and abroad, and represents the FWF at the national and international level. The members of the Executive Board are members of the Assembly of Delegates and of the FWF Board. The Scientific Vice-Presidents are each in charge of a specialist department at the FWF.

The **President** ensures the FWF's external representation, chairs the FWF Board and the Executive Board and assumes the direction of the FWF offices. The President may be deputized in all of his or her tasks by a member of the Executive Board.

The **Supervisory Board** is entrusted with numerous powers of monitoring and approval. It adopts resolutions on the FWF's annual accounts as well as its annual budget forecasts and its multi-annual and annual work plans. The Supervisory Board elects the President and the Vice-Presidents on the basis of a shortlist of three candidates submitted by the Assembly of Delegates. Upon consultation with the President, it appoints the Executive Vice-President.

The **Assembly of Delegates** makes decisions on the rules of procedure for its own activities as well as those of the Executive Board and the FWF Board and is in charge of approving the FWF's annual report. This body also submits a shortlist of three candidates for the office of President and elects the members of the FWF Board based on a proposal by the Executive Board as well as four members of the Supervisory Board.

The **Secretariat** handles day-to-day operations at the FWF. This department is headed by the FWF's Executive Board and is subdivided into three divisions:

- Specialist departments (Life Sciences, Humanities and Social Sciences, Natural and Technical Sciences, Mobility and Women's Programmes)
- Strategy departments (International Programmes; National Programmes; Policy, Evaluation, Analysis)
- Internal departments (Public Relations, Finance, Auditing, IT, Organisation & Human Resources, Legal Affairs & Committee Support).

- Decision structures for funding

The **FWF Board** is responsible for deciding on funding for research projects. The FWF Board consists of the executive board (currently five members) and the reporters of the FWF.

The **expert juries and boards** deployed in certain FWF programmes submit funding recommendations for the FWF board.

Source: https://www.fwf.ac.at/en/about-the-fwf/organisation/.

Allocation of government funding to agency (budget appropriation)

The FWF's yearly budget is part of the budget for the Federal Ministry for Education, Science and Research, which is negotiated on a yearly basis with the Ministry of Finance.

Organisation of funding activities

The FWF allocates money through various funding schemes (see table below) which are in general not discipline-specific and usually bottom-up, i.e. driven by the curiosity of the scientists. To arrive at a budget across all disciplines, the number of applications and the number of proposals granted in the past is used.

3.3.2 Overview of funding schemes

The following information is taken from the FWF website. Research topic origin: proposal topic is investigator-initiated ("bottom-up") or proposed by agency ("top-down"). "Who gets funded" refers to the "unit of funding" in the proposal, not to who actually receives the money from an accounting viewpoint.

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Stand-Alone-Projects	Stand-Alone Projects	Single Project funding (SPF)	no	bottom-up	Project	Funding of individual research in the area of non-profit oriented scholarly/scientific research.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/stand-alone-projects/
International Programmes	Joint Projects	International cooperation	no	bottom-up	Project	To support bilateral research projects with closely integrated content.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/international-programmes/joint-projects/
	Joint Seminars	International cooperation	no	bottom-up	Person	To support multiple-day workshops/seminars focusing on specific topics for the purpose of initiating bilateral cooperation projects and preparing applications for Joint Projects.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/international-programmes/joint-seminars/
	GROW - Graduate Research Opportunities Worldwide	Mobility	no	N/A	Person	GROW is a programme for supporting the international exchange of doctoral candidates from the USA jointly offered by the US National Science Foundation (NSF) and partner organisations worldwide. It offers doctoral candidates who are funded by the NSF in the framework of its Graduate Research Fellows Program (GRFP) to make research stays at scientific institutions in partner countries.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/international-programmes/grow/
Priority Research Programmes	Special Research Programmes (SFBs)	Structural priority area	no	bottom-up	Project	Special Research Programmes (SFBs) serve the creation of local "Centres of Excellence" through autonomous priority formation. Their aim is to strengthen the international competitiveness of Austrian research. Establishment of research networks based on international standards through autonomous research concentration at a single university location. Building up of extremely productive, tightly interconnected research establishments for long-term and interdisciplinary work on complex research topics."	https://www.fwf.ac.at/en/research-funding/fwf-programmes/special-research-programmes-sfb/ https://www.fwf.ac.at/fileadmin/files/Dokumente/Ueber_den_FWF/Publikationen/FWF-Jahresberichte/fwf-jahresbericht-1998.pdf, p. 39
Awards and Prizes	START Programme	SPF Early career	no	bottom-up	Person	Researchers should be given the long-term and extensive financial security to plan their research and to build up or consolidate their own research groups thereby qualifying themselves for senior research positions (especially as university professors within Austria or abroad).	https://www.fwf.ac.at/en/research-funding/fwf-programmes/start-programme/

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
	Wittgenstein-Award	Prizes	no	N/A	Person	Scholars/Scientists should be guaranteed the greatest possible freedom and flexibility in the performance of their research.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/wittgenstein-award/
Doctoral Programmes	doc.funds	Education & Training	no	bottom-up	Institution	To promote outstanding education and training for scientific and arts-based doctoral students within the framework of structured doctoral programmes that have been in operation for at least two years. To reinforce the research orientation and sustained consolidation of existing education and training structures for highly qualified junior researchers.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/docfunds/
	Doctoral Programmes (DKs)	Education & Training	no	bottom-up	Person	Doctoral Programs form centres of education for highly qualified young scientists/scholars from the Austrian and international scientific community. The programme should support centres of excellence at Austrian research institutions and help ensure the continuity and impact of such centres. A Doctoral Program may only be established at a research institution that is entitled to award doctoral qualifications.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/dks/
International Mobility	Erwin Schrödinger Fellowships	Mobility	no	bottom-up	Person	Promotion of scientific work at leading foreign research institutions; gaining experience abroad during the postdoc-phase facilitation of access to new scientific areas, methods, procedures and techniques so as to contribute - following return to Austria - to the further development of science in Austria.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/schroedinger-programme/
	Lise Meitner Programme	Mobility	no	bottom-up	Person	Highly qualified researchers of any discipline who could contribute to the scientific development of an Austrian research institution by working at it. incoming: post-doctoral researchers from abroad. reintegration: post-doctoral researchers who have left Austria and wish to return to an Austrian research institution. Strengthening of the quality and the scientific know-how of the Austrian scientific community, creation of international contacts and career development.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/meitner-programme/
Career Development for Female Scientists	Hertha Firnberg Programme	Diversification	no	bottom-up	Person	The FWF is offering extremely well qualified female scientists who are working towards a career in universities the chance of a two-stage funding for a total of six years. Improvement of the career prospects for women in Austrian research facilities, very generous support during the postdoc phase for women at the start of their scientific careers or on its resumption following maternity leave. The career development programme for female scientists is divided into the Hertha Firnberg Programme for post-docs, which aims to support women at the start of their scientific careers, and the Elise Richter Programme for senior post-docs,and the Elise Richter Program for arts-based research, Elise Richter PEEK, which aim at providing the necessary qualifications to apply for professorial positions within Austria or abroad.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/firnberg-programme/
	Elise Richter Programme	Diversification	no	bottom-up	Person	The FWF is offering extremely well qualified female scientists who are working towards a career in universities the chance of a two-stage funding for a total of six years. To support the academic career of highly qualified female scientists and scholars and to enhance their university career. After completion of the program a	https://www.fwf.ac.at/en/research-funding/fwf-programmes/richter-programme-incl-richter-peek/

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
						level of qualification should be accomplished which enables participants to apply for a local or abroad professorship (""Habilitation"" or equal qualification). The career development programme for female scientists and academics is divided into the Hertha Firnberg Programme for post-docs, which aims to support women at the start of their academic careers, and the Elise Richter Programme for senior post-docs and the Elise Richter Program for arts-based research, Elise Richter PEEK, which aim at providing the necessary qualifications to apply for professorial positions within Austria or abroad.	
Application-oriented Basic Research	Programme Clinical Research (KLIF)	Applied Research	yes	bottom-up	Person	Funding will be available for projects in the field of non-commercial clinical research that are thoroughly described in terms of objectives and methods. Commercial organisations may not have a direct commercial interest in the results. Projects must involve human patients or healthy subjects and the aim must be to generate new scientific knowledge and insights that improve clinical practice and patient treatment.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/programme-clinical-research-klif/
Support for Artistic Research	Programme for Arts-based Research (PEEK)	Thematic priority area	yes	bottom-up	Person	Support high quality and innovative arts-based research in which artistic practice is integral to the inquiry. Increase research capacity, quality and international standing of arts-based researcher in Austria. Increase both public awareness and awareness within the academic and the arts communities of arts-based research and its potential applications.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/peek/
Support for Scientific Publications and for Science Communication	Stand-Alone Publications	Scientific Communication	no	bottom-up	Publisher	Promotion of stand-alone publications in order to make them available to a broader public. In addition to conventional publication forms (e.g. monographs, collections), the FWF also supports new formats such as apps, wiki-based publications, annotated scientific databases, web-based publications enriched with various media (e.g. audio, video, animation), etc.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/stand-alone-publications/
	Peer-reviewed Publications	Scientific Communication	no	N/A	Publisher	Grants to cover the costs of peer-reviewed publications that result from projects supported by the FWF, up to a limit of three years after conclusion of the project.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/peer-reviewed-publications/
	Science Communication Programme (WissKomm)	Scientific Communication	no	N/A	Person	In 2018 the FWF is celebrating its 50th anniversary. This year, the FWF's science communication activities will be bundled for the "BE OPEN – Science Society Festival". For this reason the FWF has decided to suspend the call for proposals for the Science Communication Programme in 2018. This phase will also be used to continue to develop the programme in terms of modularisation in order to optimally meet the requirements of the scientific community in the future.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/science-communication-programme-wisskomm/
Expansion Projects to FWF-funded Projects	Top Citizen Science Funding Initiative	Other	no	N/A	Person	In consultation with the Austrian Federal Ministry of Science, Research and Economy (BMWFW), the FWF and OeAD have issued a call for the "Top Citizen Science" (TCS) funding initiative for the third time, which has a total endowment of € 500,000 (€ 250.000 FWF and € 250.000 OeAD). Under this call, funding will be made available for the expansion of FWF funded research- projects or OeAD funded Sparkling Science projects which are suitable in terms of content and methods and which are to be expanded to include ""citizen-science""-components.	https://www.fwf.ac.at/en/research-funding/fwf-programmes/top-citizen-science-funding-initiative/

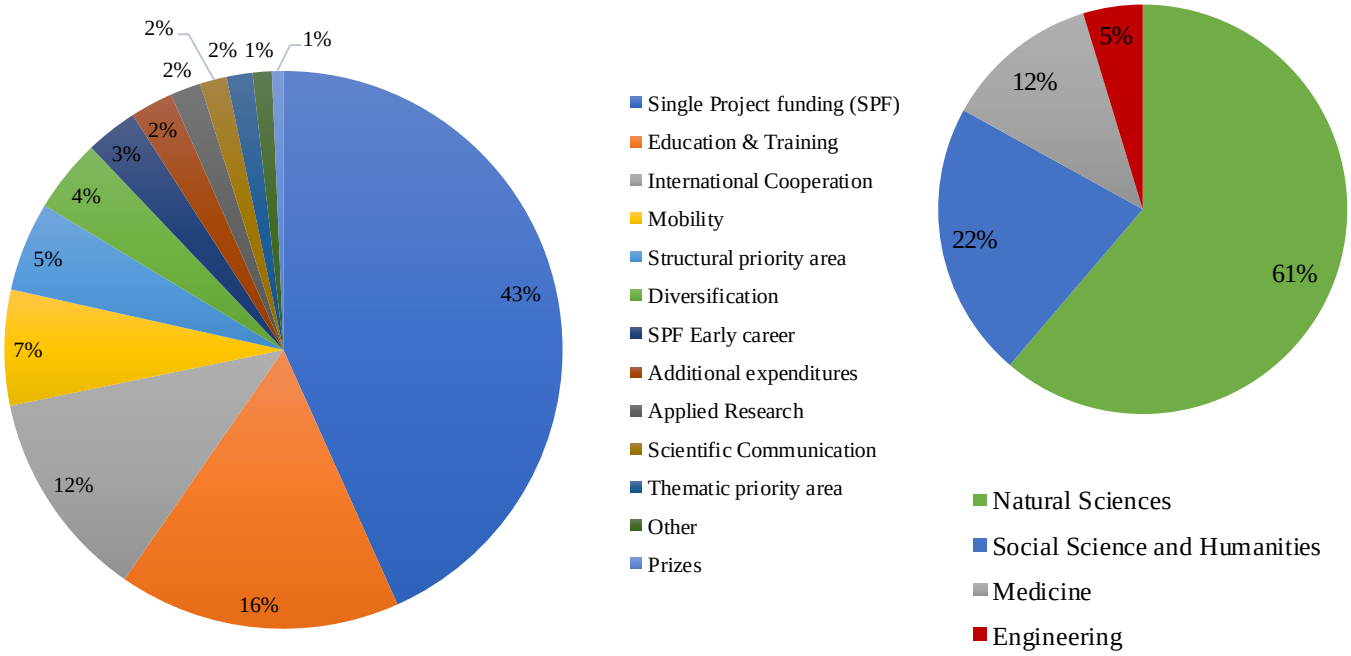
Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
						In the context of this initiative, it is understood as the active involvement of citizens and their knowledge, resources and commitment in scholarly research and the generation of new scholarly insights.	

Source: FWF website https://www.fwf.ac.at/en/research-funding/fwf-programmes/. Note: Only programmes are listed for which there were expenditures in 2017. EU Projects are not listed. Bottom-Up/Top-Down is assessment by WIFO based on the online description of the funding schemes and the application documents.

3.3.3 *Characteristics of funding schemes*

As in most other agencies, single project funding dominates in the funding portfolio, followed by education & training. The FWF has no infrastructure funding scheme, literally no translational schemes except for clinical research, and few collaborative/network-style funding schemes, with the exception of the Special Research Programmes (SFB). The FWF has however a much higher share of international cooperation (which is aimed both at international cooperation between Austrian researchers and researchers in developed countries, such as Germany, Switzerland and Japan, and in developing or emerging countries, such as India, Russia and China) which contains collaborative funding schemes. One special feature of the FWF is also the fact that 1.5% of the total budget goes to publication costs (above all Open Access). In terms of disciplines, within Single project funding the FWF shows a very high share of natural sciences and of social sciences & humanities, while engineering and medicine achieve comparatively very low shares. However, some of biological research (classified within natural sciences) may also be close to medicine, so that the share of medicine should be treated with caution.

Figure 6: FWF total awarded funding according to study author classification (left panel) and share of disciplines in Single Project funding (right panel), 2017



Source: FWF Annual reports, WIFO calculation. Note: The category "Other" includes programmes that cannot be classified according to the study author classification. These programmes are "Top Citizen Science Funding Initiative (TCS)" and "Open Research Data (ORD)". The category "Additional expenditures" includes expenditures for EU projects and supplementary funding. The right panel shows shares of disciplines in Single project funding (SPF). Natural Sciences include the FWF disciplines natural science and agricultural sciences as well as veterinary medicine. Social Sciences include the FWF disciplines social sciences and humanities.

Table 8: Selected characteristics of the funding schemes, 2017

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)*	Duration of funding (statistical*)	Success Rate
Total		**100%**	**N/A**	**0.34**	**N/A**	**N/A**	**26%**
Project funding		**46%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Single project funding (SPF)	Stand-Alone Projects	43%	max. 0.4 Mio. EUR/project	0.33	max. 4 years; for specific projects longer period possible (repeated application necessary)	N/A	29%

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)*	Duration of funding (statistical*)	Success Rate
SPF Early career	START Programme	3%	min. 0.8 – max. 1.2 Mio. EUR	1.13	6 years (interim review after 3 years)	N/A	7%
SPF high-risk		-	-	-	-	-	-
Networks and Multi-Project funding		-	-	-	-	-	-
Interdisciplinary research		-	-	-	-	-	-
Priority areas		**7%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Structural priority area	Special Research Programmes (SFBs)	5%	1 Mio. EUR/year (benchmark)	0.43	8 years (interim review after 4 years)	N/A	new applications: 5,3%; extensions: 83,3%
Thematic priority area	Programme for Arts-based Research (PEEK)	2%	depending on the individual project, project-specific costs may be requested	0.38	max. 4 years	N/A	13%
Infrastructure		-	-	-	-	-	-
Funding of people		**28%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Education & Training		16%	N/A	2.05	N/A	N/A	N/A
	doc.funds	5%	Education and training costs max. 5,000 EUR/year for each PhD position (5-10 PhD candidates), 5% general project costs	1.61	4 years	N/A	16%
	Doctoral Programmes (DK)	11%	N/A	2.33	8 years (interim review after 4 years)	N/A	new applications: 25%, renewals: 87,5%
Career		-	-	-	-	-	-
Diversification		4%	N/A	0.25	3 years	N/A	23-25%
	Hertha Firnberg Programme	2%	personnel costs: 66,070 EUR/year; project-specific costs: max. 12,000 EUR/year	0.23	3 years (up to 1 year therefrom can be spent at research facilities abroad)	N/A	25%
	Elise Richter Programme	2%	personnel costs: 72,630 EUR/year; project-specific costs: max. 15,000 EUR/year	0.28	1-4 years	N/A	23%
Prizes	Wittgenstein-Award	1%	max. 1.5 Mio. EUR/prize	1.5	5 years	N/A	5%
Mobility		7%	N/A	0.15	3 years	N/A	N/A
	Erwin Schrödinger Fellowships	3%	fellowships abroad: 34,100-46,400 EUR/year (depends on the destination), return phase: 72,630 EUR/year personnel costs; max. 12,000 EUR/year project specific costs	0.14	fellowship abroad: 10-24 months; return phase: max. 1 year	N/A	36%
	Lise Meitner Programme	4%	personnel costs: 66,070 EUR/year for post-doc, 72,630 EUR/year for senior post-	0.16	2 years (not renewable)	N/A	24%

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)*	Duration of funding (statistical*)	Success Rate
			doc; project-specific costs: max. 12,000 EUR/year				
	GROW - Graduate Research Opportunities Worldwide	0.01%	2,112.40 EUR (gross salary/30hrs for doctoral candidates)	0.03	10-12 months	N/A	N/A
International Cooperation		**12%**	**N/A**	**0.26**	**N/A**	**N/A**	**N/A**
	Joint Projects	12%	N/A	0.27	max. 3 or 4 years (depending on which country)	N/A	22%
	Joint Seminars	0.01%	FWF up to 0.01 Mio. EUR per joint seminar	0.01	2-4 days	N/A	N/A
Translation		**2%**					
Applied Research	Programme Clinical Research (KLIF)	2%	depending on the individual project project-specific costs may be requested	0.31	max. 4 years	N/A	16%
R&D Collaboration with firms		-	-	-	-	-	-
Commercialisation		-	-	-	-	-	-
R&D Value Chain		-	-	-	-	-	-
Scientific Communication		**2%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
	Stand-Alone Publications	0.3%	innovative publication formats: lump-sum grant of max. 50,000 EUR; conventional publication formats: lump-sum grant of max. 10,000 EUR	N/A	N/A	N/A	N/A
	Peer-reviewed Publications	1%	max. 2,500 EUR for journal articles and similar peer-reviewed publication formats; max. 8,000 EUR for monographs, complete collections and proceedings.	N/A	N/A	N/A	N/A
	Science Communication Programme (WissKomm)	0.1%	max. 50,000 EUR per application	0.04	N/A	N/A	22%
Other		**1%**	**N/A**	**0.13**	**N/A**	**N/A**	**30-39%**
	Top Citizen Science Funding Initiative (TCS)	0.1%	max. 50,000 EUR per application	0.04	max. 2 years	N/A	39%
	Open Research Data (ORD)	1%	N/A	0.18	N/A	N/A	30%

Source: FWF Annual reports; Data and information provided by FWF. Note: Lot size is the size of the total grant (the total amount of money granted for the researcher's proposal) which will usually be consumed over a period of several years (funding duration). Lot size according to application documents is the maximum amount of money researchers can ask for (or the minimum-maximum range); Lot size statistical is the actual average amount of money paid out for granted projects. Minor deviations due to rounding. A "-"-sign indicates that data/the scheme do not exist at all ; "N/A" indicates that an assessment category is not applicable to the individual funding scheme, or that data are not available. The category "Other" includes programmes that cannot be classified according to the study author classification. *The duration of many FWF programmes can currently be extended by 6 months, provided that no additional costs are incurred.

Individual project grants cannot be renewed, although a new proposal can build on previous funded projects (but must go through the normal review process); it does not happen often according to the FWF and data are hard to come by.

3.3.4 Refundable costs and review procedures of single project funding

- wage of the applicant only for PIs without an employment contract, for details see the FWF application guidelines[3],
- wages of scientific/technical staff,
- material expenses (consumables and smaller pieces of equipment, if it is specifically required for the project concerned and if it does not constitute basic equipment (i.e. part of an institution's infrastructure)),
- mobility (Travel (incl. accommodation and catering costs), conferences and workshops),
- third-party expenses (Costs of project partners (not wages)).

- Indirect cost rate (overheads): -
  The FWF currently does not pay indirect costs.

Source: https://www.fwf.ac.at/fileadmin/files/Dokumente/Antragstellung/Einzelprojekte/p_application-guidelines.pdf, https://www.fwf.ac.at/de/news-presse/news/nachricht/nid/20150323-2113/.

Table 9: Overview of review process (Stand-Alone-Projects)
The following information is taken from the FWF website.

Internal/External reviewers:	**Internal** (domestically working, external researcher who are elected for a period of four years – the so-called Reporters) and **external reviewers**
Number of reviewers (per proposal):	At least **two** external **reviewers** for Stand-Alone Projects up to a requested funding amount of 400,000 EUR. An additional review is required for each additional 200,000 EUR requested.
International/National reviewers:	Only international reviewers (researcher working outside Austria)
Organisation of Review:	**1st stage mail review** by external reviewers in which they are asked to address specific questions in relation to the proposal. External reviewers are chosen by the Reporters together with the FWF Office, the "internal" reviewers (see above). At the same time, reviewers are asked to provide an overall formal assessment (i.e. rating) for each specific question using a five-point scale (see below). Applicants can refuse up to three reviewers. **2nd stage panel review** by FWF Board. **Each review consists of two sections:** The first section is transmitted to the applicant in its entirety (incl. the overall ratings). In the second section, reviewers can provide additional, confidential remarks to the FWF. The FWF provides the reviewers with a brief explanation of the quality standards that should form the basis for the formal ratings (see below for detailed information): **Excellent = funding with highest priority** **Very Good = funding with high priority** **Good = resubmission with some revisions** **Average = resubmission with major revisions**

[3] See https://www.fwf.ac.at/en/research-funding/application/stand-alone-projects/, application guidelines, appendix I, 2.2.

	Poor = rejection **Funding decisions:** The Reporter responsible for the application presents it to the Board, together with a summary of the reviews received as well as any comments received from the Alternate(s). In most cases, decisions are made unanimously, often after a detailed discussion and comparison of the applications submitted. After the FWF Board meeting, the decision letters are prepared by the FWF office and dispatched to the applicants.
Assessment criteria (incl. weights or relative importance, if available):	**The reviewers are asked to respond to the following questions; there are no weights, each answer is rated according to a five-step scale (see above).** Section 1 (to be transmitted to the applicant in its entirety): • 1 Scientific/scholarly quality of the proposal with special attention to strengths and weaknesses • 2 Approach/methods and feasibility of the proposal with special attention to strengths and weaknesses • 3 Research-related qualifications of the researchers involved (based on their academic age) with special attention to strengths and weaknesses • 4 Ethical issues • 5 Overall evaluation with regard to key strengths and weaknesses and final funding recommendation Section 2 (confidential remarks to the FWF) • Other comments intended solely for the FWF
Special criteria for early-career investigators:	Yes. In the course of the FWF Board discussion, bonuses for early-stage applicants (up to 8 years after conferral of doctorate) may be applied.

Source: https://www.fwf.ac.at/fileadmin/files/Dokumente/Entscheidung_Evaluation/fwf-decision-making-procedure.pdf.

Additional information

Five-point rating scale

Excellent = funding with highest priority

The proposed research project is among the best 5% in the field worldwide. It is potentially ground-breaking and/or makes a major contribution to knowledge. The applicant and the researchers involved possess – relative to their academic age – exceptional qualifications by international standards.

Very good = funding with high priority

The proposed research project is among the best 15% in the field worldwide. It is at the forefront internationally, but minor improvements could be made. The applicant and the researchers involved possess – relative to their academic age – high qualifications by international standards.

Good = resubmission with some revisions

The proposed research project is internationally competitive but has some weaknesses, and/or the applicant and the researchers involved possess – relative to their academic age – good qualifications by international standards.

Average = resubmission with major revisions

The proposed research project will provide some new insights but has significant weaknesses and/or the applicant and the researchers involved possess – relative to their academic age – fair qualifications by international standards.

Poor = rejection

The proposed research project is weak, and/or the applicant and the researchers involved lack sufficient qualifications by international standards.

3.3.5 Important changes over time

Changes at the level of the agency

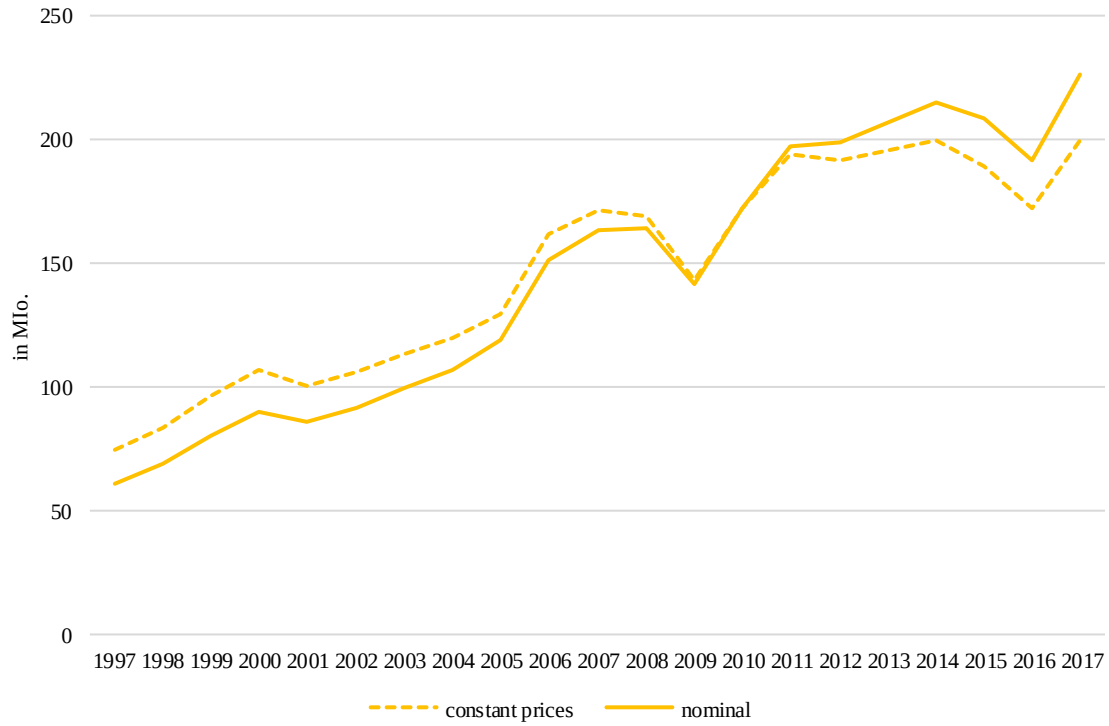
- Changes in organisational structure:

In 2015, the FWF's governance structure was reformed by introducing a supervisory board.

- Changes in overall funding levels

The total funding awarded by the FWF increased over time, but not linearly, as both at the time of the economic crisis 2008 and in recent years total funding awarded actually dropped.

Figure 7: FWF total funding awarded in current and constant EUR, 1997-2017

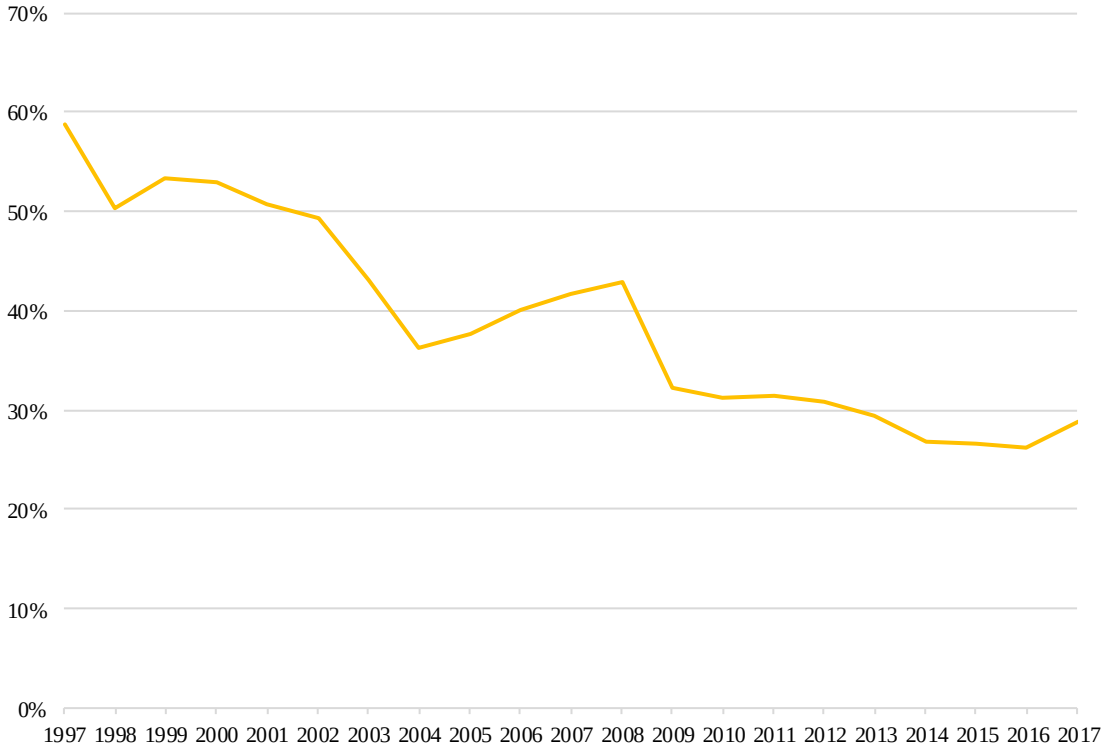


Source: FWF Annual reports, AMECO database for BIP deflator (2010=100), WIFO calculation. Note: Data of total funding awarded "nominal" is taken from the FWF's annual reports. However, the content of the definition of total funding awarded has changed over time, so that funding before 2005 is slightly overestimated.

Changes at the level of the individual funding schemes

The success rate in single project funding dropped considerably since 1997, from a level of close to 60% to close to 30%.

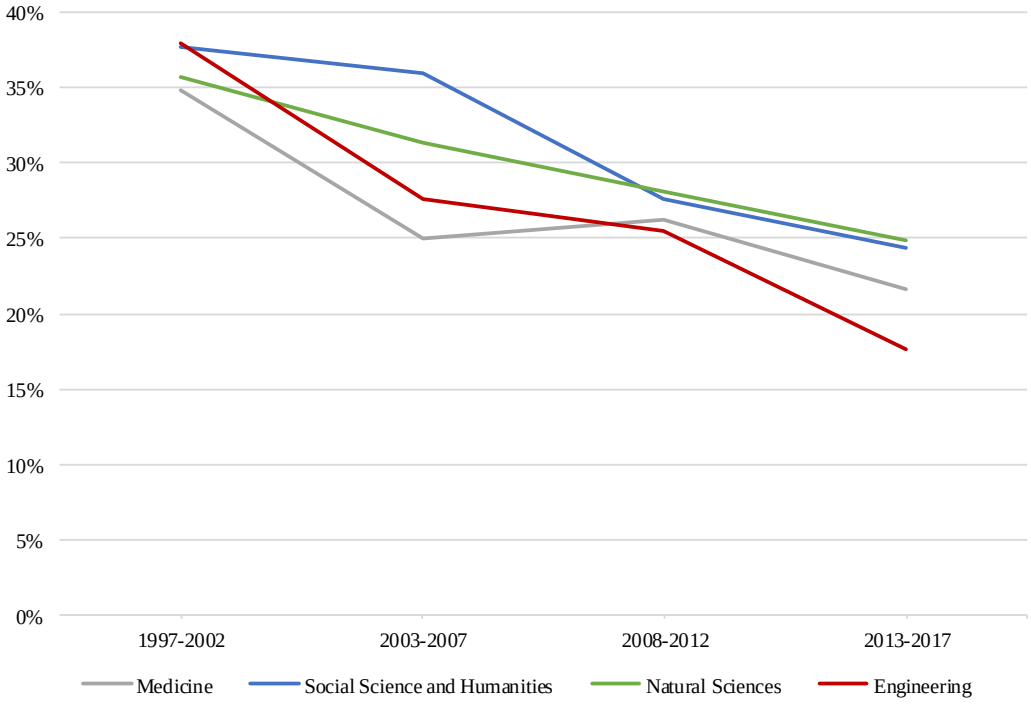
Figure 8: Success Rate in Single project funding, 1997-2017



Source: FWF Annual reports.

Success rates by disciplines generally move in the same direction, indicating common factors at play. Engineering has dropped from the highest level in 1997-2002 to the lowest level in 2013-2017. Differences with the overall single project funding success rate are explained by averaging data over 5 years.

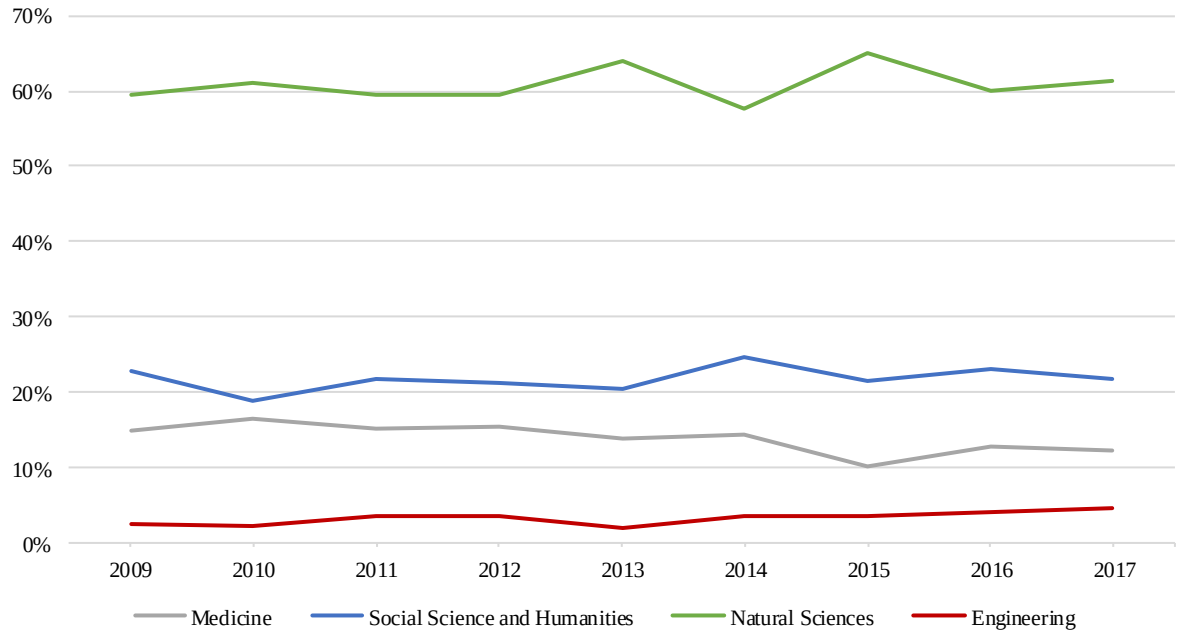
Figure 9: Success Rate in Single Project funding by discipline, 1997-2017



Source: Data was provided by FWF. Note: Disciplines proposed by study authors. The success rates refer to the proportion of the granted funding in relation to the requested funding. Data grouped in blocks of 5-6 years.

The share of the disciplines over time has stayed remarkably stable, again indicating common factors at play when considering the changing success rates at the level of the disciplines – e.g. in engineering, there must have been a higher increase in applications than in social sciences and humanities.

Figure 10: Total awarded funding in Single project funding by discipline - Austria, 2009-2017



Source: Data sent by FWF.

Otherwise, some structural changes from April 1, 2016 onward included the following:

- Each researcher will be allowed to serve as the principal investigator in a maximum of two projects in the following programmes: Stand-Alone Projects, International Programmes, Clinical Research (KLIF) and Arts-Based Research (PEEK).
- In addition, the amount of funding that can be requested in those programmes will be limited to a maximum of €400,000.00 per project.
- At the same time, the maximum duration of projects in the programmes will be extended from 36 to 48 months,
- while the option of extending a project's duration (without additional costs) will be shortened from 24 to 6 months.

These measures of limitation (number and volume) are due to budget problems and will soon be repealed.

Source: https://www.fwf.ac.at/en/news-and-media-relations/news/detail/nid/20160316-2176/?tx_rsmnews_detail%5Bref%5D=l&cHash=1f6724519c1949ff2acebfc8c9a460f5, information provided by FWF.

- Shifts in budget shares between schemes

Noteworthy is the relative increase of the people programmes at the expense of single project funding, particularly due to the introduction of funding schemes for doctoral programmes, as well as the increase of international cooperation schemes. The reduction in the share of interdisciplinary funding schemes is to some extent misleading, as the standard single project funding scheme accepts interdisciplinary proposals.

Table 10: FWF shares of funding instruments, change in percentage points between 1997-2017

	Share in 2017	Change of share 1997-2017 in percentage points
Project funding	**46.3%**	**-24.8**
Single project funding (SPF)	43.3%	-24.7
SPF Early career	3.0%	+3.0
SPF high-risk	-	-
Networks and Multi-Project funding	-	-
Interdisciplinary research	-	-3.1
Priority areas	**6.7%**	**-0.6**
Structural priority area	5.2%	-2.1
Thematic priority area	1.5%	+1.5
Infrastructure	**-**	**-**
Funding of people	**27.9%**	**+20.8**
Education & Training	16.3%	+16.3
Career	-	-
Diversification	4.2%	+3.5
Prizes	0.7%	+0.7
Mobility	6.7%	+0.2
International Cooperation	**12.1%**	**+12.0**
Translation	**1.8%**	**+1.8**
Applied Research	1.8%	+1.8
R&D Collaboration with firms	-	-
Commercialisation	-	-
R&D Value Chain	-	-
Scientific Communication	**1.5%**	**+1.5**

Source: FWF Annual reports, WIFO calculation. Note that interdisciplinary projects can also be funded in other schemes.

- Closure of funding schemes, introduction of new funding schemes:
  - Decided for now: for the programme doc.funds the Doctoral Programmes (DKs) were discontinued, only renewals are possible.
  - Relatively new programmes are: Weiss Prize, ASMET Research Award, netidee SCIENCE and Projects Herzfelder-Stiftung, all funded by private sponsors, but there is only one project per year.
  - New but not yet decided: Young Independent Researcher Groups and Research Groups.

Source: for mentioned programmes, see: https://www.fwf.ac.at/en/research-funding/fwf-programmes/; information provided by FWF.

Structural changes in allocation of funding (e.g. review procedures, overhead costs, etc.)

- Minimal changes of review forms in 2015, with no great impact.
- Overheads were abolished again in 2011.

Source: Information provided by FWF.

3.3.6 Information and data sources

Contact at fund

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Information about funding schemes:

Annual reports of FWF
https://www.fwf.ac.at/en/about-the-fwf/publications/publication-types/10/publication-view/single/back/230/

FWF website
https://www.fwf.ac.at/en/

FWF funding statistics 2009-2017
https://zenodo.org/record/1310774#.W7yGFCCYSUl

- Additional data from 2008-1997 sent by FWF

3.4 Netherlands Organisation for Scientific Research (NWO)

3.4.1 Organisational mission and structure

Mission focus

NWO focuses more broadly on funding scientific research and on its potential impact or utilisation, as well as being involved in national coordination of thematic research strategies (e.g., within the Dutch "Top Sectors" sectoral prioritisation policy). The following information was taken from the NWO website:

NWO's mission is to advance world-class scientific research that has scientific and societal impact. NWO approaches that from its vision of being a connector and is guided by its core values: groundbreaking, committed, reliable, and connecting. For the coming strategic period, NWO has established five ambitions along which the mission will be shaped.

- Ambition 1: Nexus role (NWO will ensure increased coordination in Dutch science so that a national research strategy can be developed, including a regularly updated Dutch National Research Agenda. In this, thematic and curiosity-driven research will be kept in balance.)
- Ambition 2: People (Good research requires good researchers. NWO will ensure that researchers in the Netherlands can continue to develop in all phases of their career)
- Ambition 3: Research (Fundamental research forms the basis for excellence and innovation. Consequently, curiosity-driven and fundamental research will remain an important focus for NWO with programmes for high-risk pioneering research.)
- Ambition 4: Infrastructure (Research infrastructure plays an important role in all areas of science. In this regard, not just the 'hard' equipment and ICT-facilities are important, but also the technical support and a professional environment where brainpower is concentrated and people meet.)
- Ambition 5: Knowledge sharing (Besides having a scientific impact, research should also generate societal impact that contributes to the solving of societal issues. NWO wants to facilitate knowledge sharing by increasing the collaboration with users. In doing so, NWO will further build upon the experience of various NWO units.)

Source: https://www.nwo.nl/en/about-nwo/mission+and+vision, https://www.nwo.nl/en/about-nwo/strategy.

Overarching decision structures

NWO works as a governmental agency rather than an academic self-governance body, i.e. academic scientists have an advisory role rather than a formal say in decisions on funding policy. It has both intra-mural research centres and provides extra-mural funding to researchers.

Organisational chart: https://www.nwo.nl/binaries/content/gallery/nwo/algemeen/over-nwo/organogram_2017_uk.jpg.

- General/strategic decision making

As an independent directive body (founded in 1950) with the authority to distribute public resources, NWO falls under the responsibility of the Ministry of Education, Culture and Science. The tasks and responsibilities are established in the NWO Act. The NWO Regulations define how the decentralised structure is composed, how decision-making proceeds and which principles are used for this. The NWO Regulation on Granting describes who may request funding from NWO and the framework of the assessment process and project management. NWO uses a code of good governance (the Dutch Code of 'Goed Bestuur') as a guideline to give account for its public governance structure.

NWO falls under the responsibility of the Minister of Education (OCW). In order to properly take on this ministerial responsibility the Minister has a number of powers described in the NWO Act:

- to appoint and discharge members of the Executive Board

- to approve changes to the NWO Regulations (which describe the organisation's management and constitution as well as its relations with the research organisations)
- to form an opinion on the strategic plan
- to approve the budget
- to approve the annual accounts (part of the annual financial report)

The Minister consults with NWO's Executive Board once or twice a year.

The Executive Board is responsible for carrying out NWO's duties. Under NWO come domain boards, research institutes and temporary taskforces. The Executive Board appoints or approves the appointment of members in the boards of these organisations. The NWO Regulations stipulate the rules to be followed in the NWO organisation. These rules have been further specified in covenants, guidelines and other regulations.

In order to effectively accomplish its public tasks NWO maintains well-regulated relations with other departments and other (intermediary) organisations in the scientific field, such as the VSNU, universities, KNAW, Ministry of Economic Affairs, the EU, and Research Councils across Europe. The Executive Board is accountable to the Minister. In addition, it is self-evident that a public organisation like NWO must administer public means in a responsible way and be publicly accountable for it.

- Organisation of funding decisions

NWO (the executive board) appoints a selection committee or jury for each funding instrument, usually senior researchers and experts from industry and civil society, experienced in assessing research. Its task is to compare and assess the research proposals. The committee or jury has access to all the research proposals as well as the referees' reports and applicants' rebuttals. An interview or site visit can also form part of the assessment procedure. Based on this information, the selection committee issues a funding advice to the NWO board that takes the funding decision.

Firstly, the board assesses whether the selection committee worked according to the procedure and selection criteria described in the call for proposals. Board members have access to all relevant information such as research proposals, referees' reports, applicants' rebuttals, the description of the assessment procedure, the composition of the committee, and the assessment of the conflict of interest code. The board then takes a funding decision. Usually the board adopts the selection committee's advice. It may, however, deviate from this if it states its reasons for doing so.

Source: https://www.nwo.nl/en/about-nwo/organisation/governance, https://www.nwo.nl/en/funding/funding+process+explained.

Allocation of government funding to agency

An important part of NWO's duties is performed by providing funding to academic researchers. The financial means for this are for the most part drawn from the budget of the Ministry of Education, Culture and Science.

Organisation of funding activities

NWO operates mainly on the basis of non-discipline specific cross-cutting funding schemes. However, within these cross-cutting schemes, discipline-specific/thematic calls for research proposals may be launched.

The following information was taken from the NWO website:

NWO provides a limited palette of funding instruments with a clear number of modules. These modules can be combined in accordance with the objectives of the programme or call concerned. This approach will provide the flexibility needed to meet the needs of the various disciplines.

NWO is currently undergoing reform aimed at harmonising its instruments. This harmonisation of instruments will provide the following palette of funding lines and each line will have a distinct objective:

Talent Programme

Curiosity-driven, responsive-mode research aimed at research talent

Open Competition

Curiosity-driven research

Programmes for scientific or societal breakthroughs

Large-scale programmes based on the Dutch National Research Agenda, Knowledge and Innovation Agendas and the knowledge agendas of government ministries, where relevant in collaboration with public and/or private stakeholders

PPP

Projects or programmes in partnership with external public and/or private parties

Specific programmes

Projects or programmes in the context of, for example, the Merian Fund with third countries, the Netherlands Polar Programme, the User Support for Space Research programme, the Caribbean Research: a Multidisciplinary Approach programme, and the long-term strategic programmes of the NWO institutes

Infrastructure

Realising large-scale infrastructure

A detailed list is provided in the next section.

Source: https://www.nwo.nl/en/about-nwo/funding+lines.

3.4.2 Overview of funding schemes

The following information is taken from the NWO website. Research topic origin: Proposal topic is investigator-initiated ("bottom-up") or proposed by science fund ("top-down").

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Curiosity-driven research	Open competition	Single project funding	yes	bottom-up	Project	The Free Competition programme encourages research that is not linked to a particular theme. Several NWO divisions organise an open competition and they each set their own conditions for research projects in this.	https://www.nwo.nl/en/research-and-results/programmes/free+competition
Curiosity-driven research and talent	Aspasia (focused on female talent in higher positions)	Diversification	no	bottom-up	Person	The grant is intended to encourage the promotion of female Vidi grant candidates to an associate professorship and female Vici grant candidates to a full professorship.	https://www.nwo.nl/en/funding/our-funding-instruments/nwo/aspasia/aspasia.html
	FOm/f incentives programme (focused on female scientists in Dutch physics)	Diversification	yes	bottom-up	Person	NWO initiated the NWO Physics/f incentives programme (former FOM/v incentives programme) to keep more female scientists in the Dutch physics community.	https://www.nwo-i.nl/en/nwo-domain-science/collaboration/nwo-physicsf-network/fomf-grants/
	PhDs in the Humanities	Education & Training	yes	bottom-up	Person	PhDs in the Humanities offers talented researchers a paid PhD position. The aim of the programme is to give talented researchers the chance to obtain a PhD and acquire a tenured academic position.	https://www.nwo.nl/en/research-and-results/programmes/gw/phds-in-the-humanities/index.html
	Rubicon (experience abroad for young scientists)	Mobility	yes	bottom-up	Person	The Rubicon programme allows recently graduated scientists to gain experience at a foreign top institute. This is an important step up in a scientific career.	https://www.nwo.nl/en/research-and-results/programmes/rubicon
	Spinoza Prize (aimed at the absolute top)	Prizes	no	N/A	Person	The NWO Spinoza Prize is the highest award in Dutch science. Each year, NWO awards the NWO Spinoza Prizes to three or four researchers working in the Netherlands who according to international standards belong to the absolute top of science.	https://www.nwo.nl/en/research-and-results/programmes/spinoza+prize
	Innovational Research Incentives Scheme Veni	Career	no	bottom-up	Person	Veni is part of the Incentives Scheme. It allows researchers who have recently obtained their PhD to conduct independent research and develop their ideas for a period of three years.	https://www.nwo.nl/en/funding/our-funding-instruments/nwo/innovational-research-incentives-scheme/veni/index.html
	Innovational Research Incentives Scheme Vidi	Career	yes	bottom-up	Person	The Innovational Research Incentives Scheme Vidi is a grant for experienced researchers.	https://www.nwo.nl/en/funding/our-funding-instruments/nwo/innovational-research-incentives-scheme/vidi/index.html
	Innovational Research	Career	yes	bottom-up	Person	Vici is a funding instrument from the Talent Scheme. It gives senior researchers the opportunity to build up their own research group, often in anticipation of a	https://www.nwo.nl/en/funding/our-funding-

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
	Incentives Scheme Vici					tenured professorship. The research group must become structurally embedded in the research institution.	instruments/nwo/innovational-research-incentives-scheme/vici/index.html
	Gravitation	Structural priority area	no	bottom-up	Project	With Gravitation, the government encourages excellent research in the Netherlands. The programme is for scientific consortia that have the potential to rank among the world's best in their field. The programme is a form of direct government research funding. The Ministry of Education, Culture and Science has asked NWO to realise a selection procedure for Gravitation.	https://www.nwo.nl/en/research-and-results/programmes/gravitation
Thematic research and public-private partnership	Top sectors	R&D Collaboration with firms	yes	top-down	Project	NWO takes part in the top sectors policy of the current Dutch government. Within nine designated sectors, the collaboration between companies, researchers and the government is being encouraged. In this process, NWO ensures a good connection between the ambitions of the top sectors and the funding of scientific research within these areas.	https://www.nwo.nl/en/policies/top+sectors
International collaboration	Money follows researcher (MfR-scheme)	Mobility	no	bottom-up	Person	Via the MfR scheme, researchers who take up an appointment at another European knowledge institution can take a remainder of their funding with them. The aim is to encourage the mobility of researchers in Europe. Researchers who are eligible for the MfR scheme can submit a request to NWO.	https://www.nwo.nl/en/research-and-results/programmes/Money+follows+researcher
Large research facilities	NWO Grants for Large Research Facilities	Infrastructure	yes	bottom-up	Project	NWO structurally invests in high-value equipment and data collections. In addition, the NWO institutes make their instruments, facilities and laboratories available for research performed by colleagues both at home and abroad. With this approach, NWO strengthens the infrastructure of scientific institutions in the Netherlands	https://www.nwo.nl/en/about-nwo/key+areas/large+research+facilities
	Perspectief	R&D Collaboration with firms	yes	bottom-up	Project	The financing instrument of Perspective focuses on the encouragement of this in order to solve innovation bottlenecks. Innovative knowledge takes shape through an application which contributes to technological innovation offering potential economic impact for the Netherlands.	https://www.nwo.nl/en/research-and-results/programmes/perspectief
	Partnership	R&D Collaboration with firms	yes	bottom-up	Project	Organisations that wish to invest in a research theme can enter into a Partnership with the NWO domain of Applied and Technical Sciences (TTW). Together with the TTW, the organisation (or a consortium of organisations) translates the research need into a sharp research question. An open tender for research proposals is then organised, possibly preceded by a matchmaking between scientists and the organisation concerned. NWO then selects the best proposals, based on scientific quality, chance of application of the results and appropriateness within the theme of the Partnership programme.	https://www.nwo.nl/onderzoek-en-resultaten/programmas/partnership
	Demonstrator	R&D Collaboration with firms	yes	bottom-up	Project	researchers who want to apply and market knowledge from their research can apply to NWO for funding to further develop a technology as the basis for a commercial product. The Demonstrator programme offers scientists the opportunity to make the results of their research attractive to the market. By developing a demonstration model, researchers can demonstrate that the technology developed has commercial potential. The demonstration model can then help to arouse the interest of companies that want to buy the technology for further development into a commercial product.	https://www.nwo.nl/onderzoek-en-resultaten/programmas/demonstrator

Source: Content of funding schemes: see column link. Bottom-up/top-down is assessment by WIFO based on the online description of the funding schemes and the application documents.

3.4.3 Characteristics of funding schemes

NWO, just like the UK Research Councils and to a lesser degree the NSF, does not provide detailed funding data corresponding to the funding schemes as researchers trying to apply for the schemes would see them. In the next table, we hence juxtaposed the information on the funding portfolio as presented in the yearly annual reports with the information from the website, presented above. This was validated with NWO, however the detail of funding data is still limited.

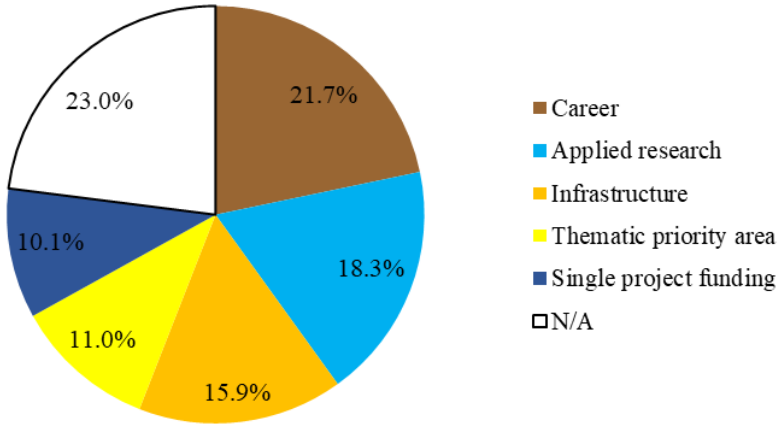
Table 11:Overview funding schemes versus data in annual report

Name of funding scheme according to NWO's website	**Corresponding programme in annual report**	**Data in annual report**	**Data for 2016**
Open competition	Open competition	yes	82.4
Aspasia (focused on female talent in higher positions)	Talent	yes for Talent category as a whole	177.6
FOm/f incentives programme (focused on female scientists in Dutch physics)			
PhDs in the Humanities			
Rubicon (experience abroad for young scientists)			
Spinoza Prize (aimed at the absolute top)			
Innovational Research Incentives Scheme Veni			
Innovational Research Incentives Scheme Vidi			
Innovational Research Incentives Scheme Vici			
Gravitation	-	Not part of NWO budget	
Top sectors	The funds disbursed are part of other programmes, as it is cross-cutting	No	
Money follows researcher (MfR-scheme)	The funds disbursed are part of other programmes, as it is cross-cutting	No	
NWO Grants for Large Research Facilities	Research infrastructure	yes	130
no information on website; according to NWO, also cross-cutting programmes	Other programmes (internationalisation and knowledge utilisation)	yes	150
no information on website; according to NWO this comprises the thematic research topics Big data Building blocks of life Circular economy Complexity Quality of life Resilient Society	Societal challenges	yes	90

Source: NWO annual reports and website, as well as information provided by NWO.

In the Netherlands, standard single project funding is hence not the most important funding category, career-oriented, translational, infrastructure and thematic schemes are more important. Note however that some of the "Talent"-schemes could also be seen as curiosity-driven project funding for early career researchers, by NWO information. In any case, the focus of the agency as defined in its mission statement can also be seen at the level of its funding portfolio, with a higher emphasis on translational and thematic priorities.

Figure 11: NWO total awarded funding according to study author classification, 2016



Source: NWO annual report, WIFO calculation.

Table 12: Selected characteristics of the funding schemes, 2016

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
Total		**100%**	**N/A**	**N/A**	**N/A**	**N/A**	**27%**
Project funding	**Open competition**	**10%**	**N/A**	**0.33**	**6 Years**	**N/A**	**22%**
Single project funding (SPF)	Open competition	10%	N/A	0.33	6 Years	N/A	22%
SPF Early career		-	-	-	-	-	-
SPF high-risk		-	-	-	-	-	-
Networks and Multi-Project funding		-	-	-	-	-	-
Interdisciplinary research		-	-	-	-	-	-
Priority areas	**Societal challenges**	**11%**	**N/A**	**0.60**	**N/A**	**N/A**	**39%**
Structural priority area		N/A	N/A	N/A	N/A	N/A	N/A
Thematic priority area	Societal challenges	11%	N/A	0.60	N/A	N/A	39%
Infrastructure	**Research Infrastructure**	**16%**	**N/A**	**0.63**	**N/A**	**N/A**	**62%**
Funding of people	**Talent**	**22%**	**N/A**	**0.35**	**N/A**	**N/A**	**19%**
Education & Training		N/A	N/A	N/A	N/A	N/A	N/A
Career	Talent	22%	N/A	0.35	N/A	N/A	19%
Diversification		N/A	N/A	N/A	N/A	N/A	N/A
Prizes		N/A	N/A	N/A	N/A	N/A	N/A
Mobility		N/A	N/A	N/A	N/A	N/A	N/A
International Cooperation		-	-	-	-	-	-
Translation	**Other programmes (internationalisation and knowledge utilisation)**	**18%**	**N/A**	**0.42**	**N/A**	**N/A**	**35%**
Applied Research	Other programmes (internationalisation and knowledge utilisation)	18%	N/A	0.42	N/A	N/A	35%
R&D Collaboration with firms		N/A	N/A	N/A	N/A	N/A	N/A

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
Commercialisation		-	-	-	-	-	-
R&D Value Chain		-	-	-	-	-	-
Scientific Communication		-	-	-	-	-	-

Source: Project duration, Success rates: Application documents and NWO Annual reports. Note: Lot size is the size of the total grant (the total amount of money granted for the researcher's proposal) which will usually be consumed over a period of several years (funding duration). Lot size according to application documents is the maximum amount of money researchers can ask for (or the minimum-maximum range); Lot size statistical is the actual average amount of money paid out for granted projects. Success rates are the share of granted applications relative to the total number of full applications. Minor deviations due to rounding. A "-"-sign indicates that data are not available; N/A indicates that an assessment category is not applicable to the individual funding scheme. * calculated by WIFO.

For individual project funding ("Open Competition"), a maximum term of 6 years and a lot size of 500,000 EUR to a maximum of 750,000 EUR apply. Note that the Open Competition cannot be renewed. Success rates in the broad programme types vary considerably, between 22% for standard single project funding and 62% for infrastructure spending.

3.4.4 Refundable costs and review procedures of single project funding

- Wages of scientific/ technical staff
- Material expenses (i.e. Costs for equipment and materials of permanent value, direct costs for the use of infrastructures (including costs for maintenance and care), consumables, field expenses, computing time and data (cloud computing), costs for making research data accessible (open research data).
- Mobility (Travel (incl. accommodation and catering costs), conferences and workshops.)
- Third-party expenses (Costs of project partners (not wages), consulting, consortia, outsourcing through subcontracting.)

Source: https://www.nwo.nl/en/funding/our-funding-instruments/nwo/free-competition/alw/open-programme.html.

Funding **cannot** be requested for permanent staff in the standard single project funding, student assistants, analysts or technicians. Funding for the PI is possible in the Innovational Research Incentives Scheme or the Rubicon. And in some grants it is allowed to apply for reimbursement of management costs, or replacement personnel. **'Overhead' costs**, such as standard office or laboratory equipment, general computer equipment, and maintenance and insurance costs, are not covered by NWO.

The size of the personnel costs to be funded can be looked up in the salary tables of the Association of Universities in the Netherlands (Dutch acronym: VSNU). The salary tables have been agreed upon in the 'Agreement for Funding Scientific Research' and are based on the collective labour agreement (Dutch acronym: CAO) of the Dutch universities.

Source: https://www.nwo.nl/en/funding/funding+process+explained/salary+tables, https://www.nwo.nl/binaries/content/documents/nwo-en/common/documentation/application/alw/open-programme---call-for-proposals/Call+for+Proposals+ALW+OP+nov2017+ENG.pdf.

Table 13: Overview of review process of ALW open competition& NWO Domain Science Open Competition – Klein

The following information is taken from the NWO website:

Internal/External reviewers:	External and internal
Number of reviewers (per proposal):	-
International/National reviewers:	Mostly international reviewers
Organisation of Review:	**1st stage: mail review** by external reviewers, organised by NWO staff (who may pre-select in case of too many applications); applicants may respond to the referees' assessments; **2nd stage:** a selection committee or jury (composed of mostly senior researchers, or non-academic experts) issues a funding recommendation to the NWO Board which takes the final funding decision; applicants can lodge an objection within six weeks, which will be addressed by an independent Appeals and Objections Committee.
Assessment criteria (incl. weights or relative importance, if available):	General assessment criteria: • scientific quality (including objective, methodology and research team) • programmatic criteria (added value, coherency, organisation) • knowledge utilisation Assessment criteria for ALW open competition: • criterion 1: originality/innovative nature, weighting 1/3 (The potential innovation with respect to the broader field of the research theme, e.g. with respect to the research question, method or result) • criterion 2: scientific quality of the proposal, weighting 1/3 (The scientific quality of the proposal must be apparent through the objectives, scientific approach, methodology, and the effect of the study: objectives must show scientific importance, approach and methodology must be clearly defined, appropriateness of working plan; effect of study relates to scientific broadening/deepening of area researched, and potential benefits for other research areas) • criterion 3: scientific quality of the group, weighting 1/6 (the PI weighs heavier than group, capability must be demonstrated by publication in international top journals, collaborations and access to equipment) • criterion 4: knowledge utilisation, weighting 1/6 (**not assessed by external peer reviewers, but by NWO Office** following a checklist of eight facultative elements:1. Are beneficiaries identified (other scientific disciplines, companies, organisations…); 2. Stakeholder feedback – are meetings or other feedback options planned with beneficiaries identified under 1? 3. Beneficiaries confirmed – which potential knowledge users are involved or committed to the project?4. Education (of researcher applied for in project); 5. How can external get access to data of the project? 6. Data distribution or integration – where will data be made accessible?7. Outreach method identified – do researchers have a plan to communicate their results to beneficiaries and general public (including patent application and all publication routes not aimed at peers) 8. Outreach timetable and budgets; the **minimum score for knowledge utilisation** will not a priori prevent applications from funding)

	Assessment criteria for NWO Domain science open competition Klein: • Criterion 1: Scientific quality of the proposal (What/Who) This includes: - the clarity of the proposal, question posed and the objectives; - scientifically innovative and/or ground-breaking elements of research proposal/investment; - the scientific approach: (challenge in) the approach and the feasibility of this; - the effectiveness in terms of methodology proposed. - appropriate expertise of the researchers involved and (access to) the equipment needed. - in the case of a proposal with an investment: the need for the investment must be made clear. • Criterion 2: Scientific and/or societal impact (Why) This includes: - the importance of potential research results in the short and long term in the own discipline; - knowledge utilisation: possible use and relevance of the knowledge generated in other scientific disciplines and/or society (economic, technical, social or cultural, for example via outreach). The criteria will be weighted as follows in the assessment: Scientific quality of the proposal is 70% of the final score, the scientific and/or societal impact 30%.

Source: https://www.nwo.nl/en/funding/funding+process+explained, https://www.nwo.nl/en/funding/our-funding-instruments/nwo/free-competition/alw/open-programme.html. ; https://www.nwo.nl/en/funding/our-funding-instruments/enw/open-competition/nwo-open-competition-domain-science---klein/nwo-open-competition-domain-science---klein.html.

3.4.5 Important changes over time

Changes at the level of the agency

- Changes in organisational structure: NWO is currently implementing a new organisational structure, the aim being to have a more efficient structure by way of clustering the current science divisions and foundations into four domains.

Source: https://www.nwo.nl/en/news-and-events/news/2015/contours-new-nwo-announced.html.

- Changes in overall funding levels

Total funding awarded increased quite significantly since 2002, in effect tripling.

Figure 12: NWO awarded funding in current and constant EUR, 1999-2016

Source: NWO Annual report, AMECO database for BIP deflator (2010=100), WIFO calculation.

Changes at the level of the individual funding schemes

- Shifts in budget shares between schemes

Due to the lack of detailed funding data, shifts in budget shares between schemes are only a very rough approximation. Basically, the share of single project funding has decreased substantially in favour of translation and infrastructure.

Table 14: NWO shares of funding instruments, change in percentage points between 2005-2017

	Share in 2017	Change of share 1997-2017 in percentage points
Project funding	**10%**	**-32.0**
Single project funding (SPF)	10%	-32.0
SPF Early career	-	-
SPF high-risk	-	-
Networks and Multi-Project funding	-	-
Interdisciplinary research	-	-
Priority areas	**11%**	**-9.8**
Structural priority area	N/A	N/A
Thematic priority area	11%	+11.0
Infrastructure	**16%**	**+8.5**
Funding of people	**22%**	**+0.4**
Education & Training	N/A	N/A
Career	22%	N/A
Diversification	N/A	N/A
Prizes	N/A	N/A

Mobility	N/A	N/A
International Cooperation	**-**	**-**
Translation	**18%**	**+18.3**
Applied Research	18%	N/A
R&D Collaboration with firms	N/A	N/A
Commercialisation	-	-
R&D Value Chain	-	-
Scientific Communication	**-**	**-**

Source: NWO Annual report, WIFO calculation.

Structural changes in allocation of funding (e.g. review procedures, overhead costs, etc.)

None

3.4.6 Information and data sources

Contact at fund

Danny ten Bosch

Finance | Information management

d.tenbosch@nwo.nl

Annual reports

2000-2006: PDF copies sent by NWO

2007-2016: https://www.nwo.nl/en/about-nwo/media/annual+report

Information about structure of fund

https://www.nwo.nl/en/about-nwo/funding+lines

https://www.nwo.nl/en/about-nwo/mission+and+vision

https://www.nwo.nl/en/about-nwo/organisation

https://www.nwo.nl/en/about-nwo/organisation/governance

Information about application and review procedures

https://www.nwo.nl/en/funding/funding+process+explained

https://www.nwo.nl/en/funding/our-funding-instruments/nwo/free-competition/gw/free-competition.html

https://www.nwo.nl/en/funding/our-funding-instruments/nwo/free-competition/alw/open-programme.html

3.5 Swiss National Science Foundation (SNSF)

3.5.1 Organisational mission and structure

Mission focus

The SNSF targets both the creation and the diffusion of knowledge. The following information is taken from the SNSF website:

The Swiss Confederation has mandated the SNSF to fund research and promote young scientists in Switzerland. The SNSF's strategy and objectives are geared to fulfilling this task and strengthening Swiss research as a whole.

The SNSF's strategic goals are derived from the Statutes and the mission statement.

- Support high-quality research as well as researchers in their quest for excellence.
- Bring research funding closer into line with the researchers' needs.
- Support the spread of knowledge in society, the economy and politics and demonstrate the value of research.

Source: http://www.snf.ch/en/theSNSF/profile/strategy/Pages/default.aspx.

Overarching decision structures

The SNSF shows features of academic self-governance, i.e. Swiss academics have a formal say in establishing general principles of the agency's operation.

- General/strategic decision making

The **Foundation Council** is the highest body of the SNSF and makes strategic decisions. It ensures that the Foundation stays on mission, defines the position of the SNSF on research policy issues and produces planning documents. The members of the Foundation Council are drawn from the most important organisations in the Swiss research community and representatives from politics and industry nominated by the Federal Council. The Foundation Council currently consists of the president, eleven representatives of the universities and Federal Institutes of Technology in Zürich and Lausanne, six representatives of the Swiss Academies of Arts and Sciences, eight representatives of the universities of applied sciences and of teacher education, seven coopted members and seven members elected by the Federal Council. The **Executive Committee** is currently composed of thirteen members of the Foundation Council (five representatives of universities, two representatives of federal institutes of technology, one representative of the Swiss Academies of Arts and Sciences, two representatives of the universities of applied sciences and of teacher education, one coopted member and two representatives elected by the federal council).

The **Compliance Committee** supports the Executive Committee of the Foundation Council in its supervisory function with regard to the scientific activities of the SNSF. The Compliance Committee reports to the Executive Committee of the Foundation Council and is elected by the latter. It has five members. The person responsible for compliance within the Executive Committee of the Foundation Council assumes the presidency.

- Decision structures for funding

The **National Research Council** of the SNSF evaluates several thousand applications each year and makes funding decisions. It is composed of about 100 distinguished researchers, most of whom work at Swiss higher education institutions. The Research Council is supported by 90 evaluation bodies comprising over 700 members. It comprises the following **four divisions**: Humanities and Social Sciences, Mathematics, Natural and Engineering Sciences, Biology and Medicine and Programmes. **Three Specialised Committees** are responsible for cross-divisional matters: International Co-operation, Careers and Interdisciplinary Research. In addition to the **permanent commissions "Gender Equality in Research Funding" and "Research Integrity",** the Research Council can appoint specialised commissions and panels for specific evaluation tasks.

The **Presiding Board** consists of the President of the Research Council and the Presidents of the divisions and specialised committees. It supervises and coordinates the work of the Research Council and drafts science policy

recommendations for submission to the Foundation Council. It focuses mainly on funding policy, the elaboration of funding schemes, evaluation methods and the distribution of funds across the individual scientific disciplines.

The **evaluation bodies** evaluate proposals and lay the groundwork for the funding decisions made by the Research Council. The members of these bodies are for the most part researchers working at higher education institutions. A third are women, and a third work at institutes based abroad.

The **Research Commissions** are based at higher education institutions and act as a link between them and the Swiss National Science Foundation. They are responsible for: awarding mobility fellowships to doctoral students (Doc.Mobility) and to postdocs starting their careers (Early Postdoc.Mobility); selecting (in the 1st phase) candidates for Doc. CH grants in the humanities and social sciences; information and advice with regard to SNSF funding schemes, particularly Doc.CH, Doc.Mobility and Early Postdoc.Mobility.

Source: http://www.snf.ch/en/theSNSF/organisation/foundation-council/Pages/default.aspx.

Allocation of government funding to agency (budget appropriation)

The following information was provided by the SNSF:

"With its multi-year programme for the attention of the federal authorities, the SNSF defines for a period of four years strategic priorities, specific instruments and measures with which it plans to achieve its objectives as well as to raise the funding necessary for implementation. The strategic objectives of the SNSF and other strategic documents serve as the framework for financial prioritisation. As part of the multi-year programme 2017 – 2020, the SNSF based its financial planning on maximum funding growth of 4.9% per annum, assigning top priority to research-driven and competition-based funding schemes.

The multi-year programme is taken into consideration in the ERI message (ERI = Education, Research and Innovation) issued by the Federal Council every four years and is the key basis for the extent of financial resources made available by the Swiss parliament to the SNSF and the other actors for the relevant funding period.

Based on the ERI message, the SNSF iteratively adjusts its content-related prioritisation and detailed financial planning activities. On this basis, the SNSF negotiates its service level agreement with the State Secretariat for Education, Research and Innovation SERI, entrenching the target values of new grants and financing requirements in a binding manner. The distribution of funds among disciplines within the scope of project funding or other bottom-up instruments remains open and is carried out annually."

Organisation of funding activities

The Swiss National Science Foundation (SNF) allocates money through various non-discipline specific funding schemes (see table below). Budget is nevertheless distributed according to 3 research domains in annual planning, according to the SNSF: Social Sciences & Humanities, STEM and Life Sciences. The repartition is based on estimations based on recent demand, were some indicators like success rates, average yearly spending, etc. are also used. The repartition is (usually) made in terms of budget and not in terms of number of grants. The output of this repartition constitutes the annual funding plan.

3.5.2 Overview of funding schemes

The following table may show discontinued funding schemes due to remaining research expenditures in 2017. Research topic origin: proposal topic is investigator-initiated ("bottom-up") or proposed by science fund ("top-down").

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Project funding	Project funding	Single project funding (SPF)	no	bottom-up	Project	Project funding can be requested by applicants who receive a salary from their home institution but who still need additional funds to carry out their research project. The applicants' own salaries are not covered by the project funding scheme. Note that researchers can declare their research proposals as "use-inspired", triggering specific evaluation criteria (see section 3.4.4.)	http://www.snf.ch/en/funding/projects/Pages/default.aspx
Careers	Doc.CH	Education & Training	yes	bottom-up	Person	Doc.CH (HSS) is aimed at promising researchers who wish to write a doctoral thesis on a topic of their own choice in the humanities and social sciences in Switzerland.	http://www.snf.ch/en/funding/careers/docch/Pages/default.aspx
	Doc. Mobility	Mobility	no	bottom-up	Person	Doc.Mobility fellowships are designed for doctoral students who wish to enhance their scientific profile by working at a research institution abroad.	http://www.snf.ch/en/funding/careers/doc-mobility/Pages/default.aspx
	MD PhD programme	Education & Training	yes	bottom-up	Person	The MD-PhD programme, a joint effort of the Swiss Academy of Medical Sciences (SAMS) and the Swiss National Science Foundation, is designed to enable research-oriented physicians to complete a second course of study at a Swiss University leading to the conferral of a doctorate in the fields of science, public health, clinical research or bioethics.	http://www.snf.ch/en/funding/careers/md-phd-programme/Pages/default.aspx
	Early Postdoc. Mobility	Mobility	no	bottom-up	Person	Early Postdoc.Mobility fellowships are designed for early-career postdocs who wish to enhance their scientific profile by working at a research institution abroad.	http://www.snf.ch/en/funding/careers/early-postdoc-mobility/Pages/default.aspx
	Advanced Postdoc. Mobility	Mobility	no	bottom-up	Person	Postdoc.Mobility (PM) fellowships replace Advanced Postdoc.Mobility (APM) fellowships with immediate effect. PM fellowships aim to support researchers who have done a doctorate and who wish to pursue an academic career in Switzerland. A research stay abroad enables them to acquire more in-depth knowledge, increases their scientific independence and enrichens their research profile.	http://www.snf.ch/en/funding/discontinued-funding-schemes/advanced-postdoc-mobility/Pages/default.aspx
	Ambizione	SPF Early career	no	bottom-up	Person	Ambizione grants are aimed at young researchers who wish to conduct, manage and lead an independent project at a Swiss higher education institution. The scheme supports young researchers both from Switzerland and abroad. Scientists holding non-professorial academic positions at higher education institutions are also eligible to submit an application.	http://www.snf.ch/en/funding/careers/ambizione/Pages/default.aspx
	Ambizione Energy	SPF Early career	yes	bottom-up/ top-down	Person	Ambizione Energy is a temporary funding measure within the scope of the Swiss Federal Council's Dispatch on the "Coordinated Swiss Energy Research" Action Plan. It was created with the aim of providing more targeted funding to young researchers in the field of energy. No further calls are currently planned.	http://www.snf.ch/en/funding/discontinued-funding-schemes/ambizione-energy/Pages/default.aspx
	SNSF professorships	Career	no	bottom-up	Person	The new SNSF Eccellenza scheme replaces SNSF Professorships starting 2018.	http://www.snf.ch/en/funding/discontinued-funding-schemes/snsf-

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
							professorships/Pages/default.aspx
	Eccellenza	Career	no	bottom-up	Person	SNSF Eccellenza Professorial Fellowships and SNSF Eccellenza Grants are aimed at highly qualified young researchers who aspire to a permanent professorship. Eccellenza supports them in achieving their goal by allowing them to lead a generously funded research project with their own team at a Swiss higher education institution.	http://www.snf.ch/en/funding/careers/eccellenza/Pages/default.aspx
	Assistant Prof. (AP) Energy grants	Career	yes	bottom-up/ top-down	Person	Assistant Professor Energy Grants is a temporary funding measure within the scope of the Swiss Federal Council's Dispatch on the "Coordinated Swiss Energy Research" Action Plan. It was created with the aim of providing more targeted funding to young researchers in the field of energy. No further calls are currently planned.	http://www.snf.ch/en/funding/discontinued-funding-schemes/assistant-professor-energy-grants/Pages/default.aspx
	Marie Heim-Vögtlin (MHV)	Diversification	yes	bottom-up	Person	During 25 years MHV grants have supported female doctoral students and postdocs in Switzerland who had to interrupt or reduce their research activities due to family commitments.	http://www.snf.ch/en/funding/discontinued-funding-schemes/mhv-grants/Pages/default.aspx
	PRIMA	Diversification (+Career)	no	bottom-up	Person	PRIMA grants are aimed at excellent women researchers who show a high potential for obtaining a professorship. PRIMA grantees conduct an independent research project with their own team at a Swiss research institution.	http://www.snf.ch/en/funding/careers/prima/Pages/default.aspx
	PROMYS	Career	no	bottom-up	Person	Promotion of talented young researchers in Eastern Europe. The initiative "Promotion of Young Scientists in Eastern Europe" (PROMYS) is aimed at young researchers in Eastern Europe who have studied or worked in Switzerland for at least two years and would like to continue their careers in a new Eastern European member state (NMS) of the EU.	http://www.snf.ch/en/funding/careers/promys/Pages/default.aspx
	International Short Visits	Mobility	no	bottom-up	Person	The scheme International Short Visits is aimed at researchers in Switzerland who wish to go abroad for a short period or researchers abroad who wish to collaborate with researchers in Switzerland. During the visit, they pursue a small joint research project.	http://www.snf.ch/en/funding/discontinued-funding-schemes/international-short-visits/Pages/default.aspx
Programmes	National Research Programmes (NRPs)	Thematic priority area	no	bottom-up	Project	NRPs embrace research projects that contribute to solving the key problems of today. Federal offices, research institutes, research groups or individual persons propose topics and potential priorities for an NRP to the State Secretariat for Education, Research and Innovation (SERI). The Federal Council makes the final selection of topics, which it then refers on to the SNSF to address within the scope of an NRP.	http://www.snf.ch/en/funding/programmes/national-research-programmes-nrp/Pages/default.aspx

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
	National Centres of Competence in Research (NCCRs)	Structural priority area	no	bottom-up	Project	NCCRs are aimed at established researchers in Switzerland who wish to pursue a long-term research project on a theme of strategic importance. The NCCR management teams are based at a higher education institution or at another renowned research institution. NCCRs are backed by one or more home institution.	http://www.snf.ch/en/funding/programmes/national-centres-of-competence-in-research-nccr/Pages/default.aspx
	Sinergia	Networks and Multi-project funding	no	bottom-up	Project	Sinergia promotes the interdisciplinary collaboration of two to four research groups that propose breakthrough research.	http://www.snf.ch/en/funding/programmes/sinergia/Pages/default.aspx
	Longitudinal studies	Applied research	yes	top-down	Project	Platforms for the promotion of translational and clinical research. Grants for multi-centric, population-based and disease-oriented studies with a longitudinal design (longitudinal studies) were given to research groups in Switzerland.	http://www.snf.ch/en/funding/programmes/longitudinal-studies/Pages/default.aspx
	SCOPES	International cooperation	no	bottom-up	Project	Together with the Swiss Agency for Development and Cooperation (SDC), the SNSF has been promoting co-operation with scientists from Eastern European countries and from the New Independent States of the former Soviet Union (NIS) since 1990 by implementing a scientific co-operation programme in seven consecutive phases. The commitment is part of a wider effort to strengthen economic, scientific and cultural ties between Switzerland and Eastern Europe and NIS.	http://www.snf.ch/SiteCollectionDocuments/int_sco_call.pdf
	r4d programme	Thematic priority area	no	top-down	Project	Research on global issues. The r4d programme of the SNSF and the SDC is aimed at researchers in Switzerland and in developing and emerging countries who wish to execute a joint research project on global issues. The programme focuses on reducing poverty and protecting public goods in developing countries.	http://www.snf.ch/en/funding/programmes/r4d-programme/Pages/default.aspx
	Bilateral programmes	International cooperation	no	top-down	Project	The bilateral programmes of the Swiss Confederation are aimed at promoting and strengthening scientific cooperation between Switzerland and non-European countries that show high or promising research potential.	http://www.snf.ch/en/funding/programmes/bilateral-programmes/Pages/default.aspx
	precoR	Applied research	yes	top-down	Project	Initiative for funding precompetitive research. precoR is open to researchers in Switzerland whose basic research projects are aimed at implementing a well-defined application, but are not yet sufficiently advanced to be implemented and strategically (co-)managed by industry partners. The initiative supports research that is capable of generating the insights needed to develop an application.	http://www.snf.ch/en/funding/programmes/precor/Pages/default.aspx

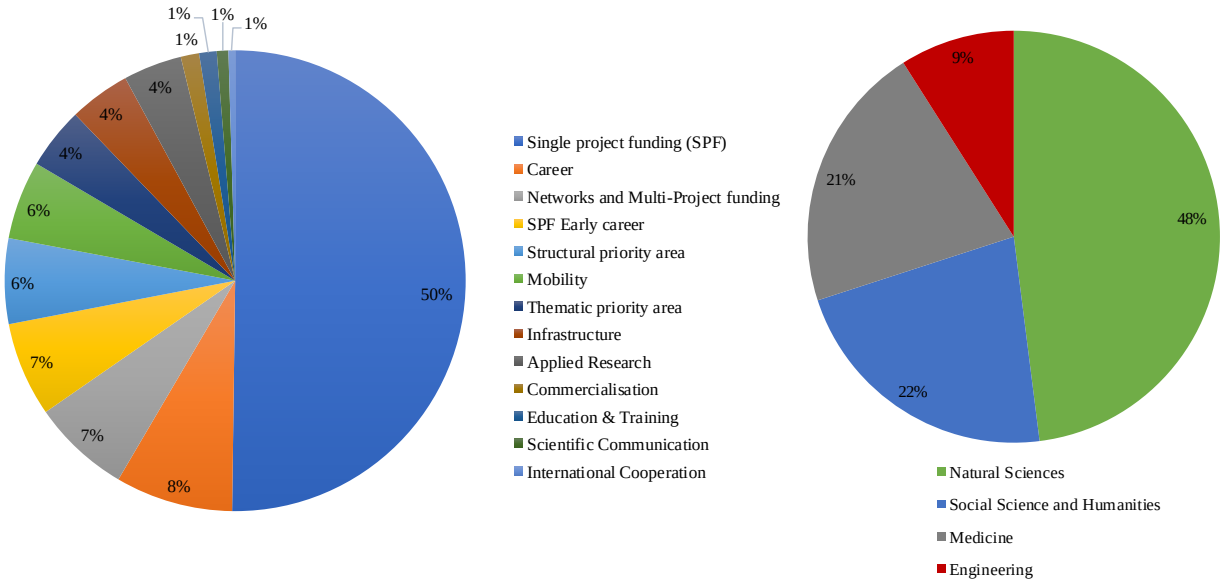
Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
	BRIDGE	Commercialisation	no	top-down	Project	BRIDGE is a joint programme conducted by the SNSF and Innosuisse – Swiss Innovation Agency. It offers new funding opportunities at the intersection of basic research and science-based innovation, thereby supplementing the funding activities of the two organisations. BRIDGE consists of two funding schemes: **Proof of Concept** is aimed at young researchers who wish to develop an application or service based on their research results. These projects may target all kinds of innovations from all research areas. **Discovery** is aimed at experienced researchers who want to explore and implement the innovation potential of research results. Only technological innovations that have a societal and economic impact will be funded.	http://www.snf.ch/en/funding/programmes/bridge/Pages/default.aspx
	IICT	Applied research	yes	bottom-up	Project	The IICT programme is targeted at researchers who wish to conduct an independent investigator initiated clinical trial. Support will be given to studies on topics that are not in the industry focus and still under-researched.	http://www.snf.ch/en/funding/programmes/iict/Pages/default.aspx
Infrastructure	R'Equip	Infrastructure	no	bottom-up	Project	R'Equip is aimed at researchers in Switzerland who need top-quality, innovative equipment for their research work. The SNSF awards grants for the acquisition and development of large-scale apparatuses in all areas of science.	http://www.snf.ch/en/funding/infrastructures/requip/Pages/default.aspx
	FLARE	Infrastructure	yes	bottom-up	Project	The FLARE programme aims at facilitating the development, construction, maintenance and operation of research infrastructures for major international experiments in particle physics, ground based astrophysics and astroparticle physics.	http://www.snf.ch/en/funding/infrastructures/flare/Pages/default.aspx
	Use of infrastructure	Infrastructure	no	bottom-up	Project	Centralised infrastructure is becoming increasingly important for research. The SNSF aims to ensure that applicants have access to the infrastructure needed to successfully complete their research projects. However, pursuant to the SNSF Funding Regulations only "the direct costs of the use of infrastructure for conducting the research project" are chargeable to the grant (FR Article 28).	http://www.snf.ch/en/funding/infrastructures/use-of-infrastructure/Pages/default.aspx
Science communication	Agora	Scientific communication	no	bottom-up	Project	The Agora scheme aims to foster dialogue between scientists and society. It encourages researchers to communicate their current research to a non-specialist audience. Agora projects have to initiate a dialogue between researchers and the target audience in which they interact and listen to each other.	http://www.snf.ch/en/funding/science-communication/agora/Pages/default.aspx
	Scientific Exchanges	Scientific communication	no	bottom-up	Person	Scientific Exchanges is aimed at researchers who want to host their own scientific event in Switzerland, invite colleagues from abroad for a research visit to Switzerland, or visit their colleagues in another country.	http://www.snf.ch/en/funding/science-communication/scientific-exchanges/Pages/default.aspx
	Publication grants	Scientific communication	no	bottom-up	Person	The SNSF finances the publication of scientific books that are freely accessible without limitations or delays (Gold Open Access). Researchers have the option to publish a printed book at the same time as the OA version.	http://www.snf.ch/en/funding/science-communication/publication-grants/Pages/default.aspx

Source: http://www.snf.ch/de/Seiten/default.aspx, Bottom-up/top-down is assessment by WIFO based on the online description of the funding schemes and the application documents.

3.5.3 Characteristics of funding schemes

Single project funding is the dominant funding scheme of the SNSF, followed by many funding scheme types of equal size, such as careers, networks, single project-funding early career, structural priority area and mobility. While there are no dedicated schemes for interdisciplinary research, note that interdisciplinary research is a goal in some funding schemes, such as the NCCRs (National Centres for Competence in Research), and there are interdisciplinary review panels within the main single project funding scheme. While curiosity-driven bottom-up research is dominant, the SNSF also features schemes with a thematic focus or translational funding schemes. Note that within single project funding, researchers can declare their research proposals to be "use-inspired" basic research. About 20% of proposals are declared as use-inspired and their success rate is lower than non-use inspired research (54% vs. 38%, over the period 2011-2015, see http://www.snf.ch/SiteCollectionDocuments/SNSF_UIBR_Final_Report_by_Technopolis_May2017.pdf). In terms of disciplines in single project funding, the natural sciences dominate, followed by social sciences and humanities as well as medicine, while engineering comes in at only 9%. Interdisciplinary research is not separately available.

Figure 13: SNSF total awarded funding according to study author classification (left panel) and shares of disciplines in single project funding (right panel), 2017



Source: SNSF Annual reports, WIFO calculation.

Table 15: Selected characteristics of the funding schemes, 2017

Funding scheme according to study scheme classification	Original fund name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
Total		**100%**	**N/A**	**0.31**	**N/A**	**N/A**	**49%**
Project funding		**63%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Single Project funding (SPF)	Project funding	50%	>0.05 Mio EUR	0.51	1-4 Years	N/A	48%
SPF Early career		7%	N/A	N/A	N/A	N/A	N/A
	Ambizione	6%	N/A	0.63	2-4 Years	N/A	31%
	Ambizione Energy	1%	ca. 0.27 Mio. EUR	0.59	3 Years	N/A	36%
SPF high-risk		-	-	-	-	-	-
Networks and Multi-Project funding	Sinergia	7%	min. 0.045 Mio. EUR - max. 2.88 Mio. EUR	1.93	1-4 Years	N/A	N/A
Interdisciplinary research		-	-	-	-	-	-
Priority areas		**10%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

Funding scheme according to study scheme classification	Original fund name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
Structural priority area	National Centres of Competence in Research (NCCRs)	6%	N/A	0.21	4 Years	N/A	N/A
Thematic priority area		4%	N/A	N/A	N/A	N/A	N/A
	National Research Programmes (NRPs)	2%	0.36 Mio. EUR	0.45	6-7 Years	N/A	N/A
	r4d programme	2%	N/A	0.9	10 Years	N/A	N/A
Infrastructure		**4%**	**N/A**	**N/A**	**N/A**	**N/A**	**71%**
	Use of infrastructure	1%	N/A	3.13	N/A	N/A	N/A
	R'Equip	1%	max. 50% of acquisition costs (~ 0.9 Mio. EUR)	0.26	N/A	N/A	N/A
	FLARE	2%	N/A	1.30	3 Years	N/A	N/A
Funding of people		**15%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Education & Training		1%	N/A	N/A	N/A	N/A	N/A
	Doc.CH	1%	N/A	0.21	2-4 Years	N/A	27%
	MD PhD programme	0.1%	N/A	0.17	max. 3 Years	N/A	100%
Career		8%	N/A	N/A	N/A	N/A	N/A
	SNSF professorships	8%	0.36 Mio. EUR/Year	1.72	4 Years (renewal for 2 Years)	N/A	16%
	Assistant Prof. (AP) Energy grants	0.4%	0.27 Mio. EUR	0.79	max. 4 Years	N/A	56%
Diversification		N/A	N/A	N/A	N/A	N/A	N/A
Prizes		-	-	-	-	-	-
Mobility		5%	N/A	N/A	N/A	N/A	N/A
	Doc.Mobility	1%	N/A	0.04	6-18 Months	N/A	47%
	Early Postdoc Mobility	3%	N/A	0.08	12-18 Months	N/A	45%
	Advanced Postdoc Mobility	2%	N/A	0.11	24 Months (scholarship), 3-12 Months (return phase)	N/A	36%
	International short visits	0.1%	N/A	0.01	1-12 weeks	N/A	N/A
International Cooperation		**0.5%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
	Bilateral programmes	0.2%	N/A	0.22	3-4 Years	N/A	N/A
	SCOPES	0.01%	0.01 Mio. EUR	0.01	3 Years	N/A	N/A
	Multilateral cooperation	0.2%	N/A	0.52	N/A	N/A	N/A
Translation		**5%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Applied Research		4%	N/A	N/A	N/A	N/A	N/A
	Investigator initiated clinical trial (IICT)	1%	N/A	1.39	3-5 Years	N/A	N/A
	Longitudinal studies	3%	1.8 Mio. EUR/Year	3.65	max. 3 Years	N/A	N/A
R&D Collaboration with firms		-	-	-	-	-	-
Commercialisation	BRIDGE	1%	N/A	0.33	Proof of concept: 1-1 1/2 Years.	N/A	N/A

Funding scheme according to study scheme classification	Original fund name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
					Discovery: max. 4 Years		
R&D Value Chain		-	-	-	-	-	-
Scientific Communication		**1%**	**N/A**	**N/A**	**N/A**	**N/A**	**85%**
	Agora	0.3%	0.0045-0.045 Mio. EUR	0.16	max. 3 Years	N/A	N/A
	Scientific Exchanges	0.2%	min. 0.0023 Mio. EUR - max. 0.023 Mio. EUR	0.01	1-6 Months	N/A	N/A
	Scientific Conferences	0.1%	N/A	0.01	N/A	N/A	N/A
	Publication grants	0.1%	N/A	0.01	N/A	N/A	N/A
	International exploratory workshops	0.02%	N/A	0.01	2-5 days	N/A	N/A

Source: Application documents and website for Lot size and Project duration, Annual reports for Success rates, information provided by SNSF. Note: Lot size is the size of the total grant (the total amount of money granted for the researcher's proposal) which will usually be consumed over a period of several years (funding duration). Lot size according to application documents is the maximum amount of money researchers can ask for (or the minimum-maximum range); Lot size statistical is the actual average amount of money paid out for granted projects. Lot sizes have been converted from CHF to EUR. Exchange rate from January 1, 2017: 0.9. Minor deviations due to rounding Success Rate is calculated by SNSF: Number of approved applications divided by applications submitted. A "-"-sign indicates that data/the scheme do not exist at all ; "N/A" indicates that an assessment category is not applicable to the individual funding scheme, or that data are not available.

Not with respect to funding duration that full grants can in principle not be renewed, but an exception is that project grants can be renewed through so-called "excellence grants", for about the same period of time as the original project grant without having to go through external reviewing again.

Approximately 1.5% of the single projects are renewed as "excellence projects". In 2017 it was 1.7%.

Source: see Article 36, http://www.snf.ch/en/funding/documents-downloads/Pages/regulations-funding-regulations.aspx#br_a_36; Data was provided by the SNSF.

3.5.4 Refundable costs and review procedures of single project funding

- Applicants own salaries only in specific schemes (e.g. Ambizione, PRIMA)
- Wages of scientific/technical staff,
- Material expenses (i.e. Costs for equipment and materials of permanent value, direct costs for the use of infrastructures (including costs for maintenance and care), consumables, field expenses, computing time and data (cloud computing), costs for making research data accessible (open research data),
- Mobility (Travel (incl. accommodation and catering costs), conferences and workshops,
- Third-party expenses (Costs of project partners (not wages), consulting, consortia, outsourcing through subcontracting),
- Costs of scientific (open access) publications,

Source: see article 28 in http://www.snf.ch/SiteCollectionDocuments/allg_reglement_16_e.pdf.

- Indirect cost rate (overheads): 20%

The indirect costs are allocated directly to the research institution.

Source: http://www.snf.ch/SiteCollectionDocuments/ueb_overhead_reglement_e.pdf, http://www.snf.ch/en/researchinFocus/newsroom/Pages/news-131126-overhead.aspx, http://www.snf.ch/SiteCollectionDocuments/projektfoerderungsreglement-e.pdf.

Table 16: Overview of review process

The following information is taken from the SNSF website:

Internal/External reviewers:	both
Number of reviewers (per proposal):	two internal reviewers (members of the Research Council) and at least two external reviewers (in practice between 3 and 5)
International/National reviewers:	both (external reviewers are mostly solicited internationally)
Organisation of Review:	**Two step procedure:** **First Step: mail review** by external peer reviewers, also **reader system**[1] or **panel**[2] (if numerous comparable applications are received within the same discipline). **Second Step**: External reviews are assessed by internal reviewers/referees of the Research Councils. In case of small grants in case of grant renewal, the Research Council may decide to drop external review; referees of Research Council make recommendation on funding to evaluation bodies of Research Council, Presiding Board of Research Council takes final decision. Referees of Research Council are distinguished researchers mostly working at Swiss higher education institutions, elected for four years.
Assessment criteria (incl. weights or relative importance, if available):	**with regard to applicants** 1. scientific track record and expertise in view of the proposed project **with regard to the proposed projects** 2. scientific quality of the project: scientific relevance, originality and topicality; additionally, broader impact outside science in the case of proposals for use-inspired research 3. suitability of methods and feasibility SNSF does not have special review criteria within project funding for first-time applicants, but it has got specific early career project funding scheme such as Ambizione (see below).
Assessment criteria for Ambizione (early career project funding):	**for young investigators:** two stage evaluation procedure 1. internal review (external review upon request by the referee only), 2. invitation to an interview + mail review by external reviewers *Assessment criteria:* see criteria above + depending on the career funding scheme: education, teaching activities and aptitude for an academic career

Source: http://www.snf.ch/en/theSNSF/evaluation-procedures/project-funding/Pages/default.aspx#Evaluation%20criteria%20and%20principles.

[1] **Reader System:** several external reviewers independently receive several applications (all reviewers receive the same applications), which they then compare and appraise; they compile a ranking of all reviewed applications.

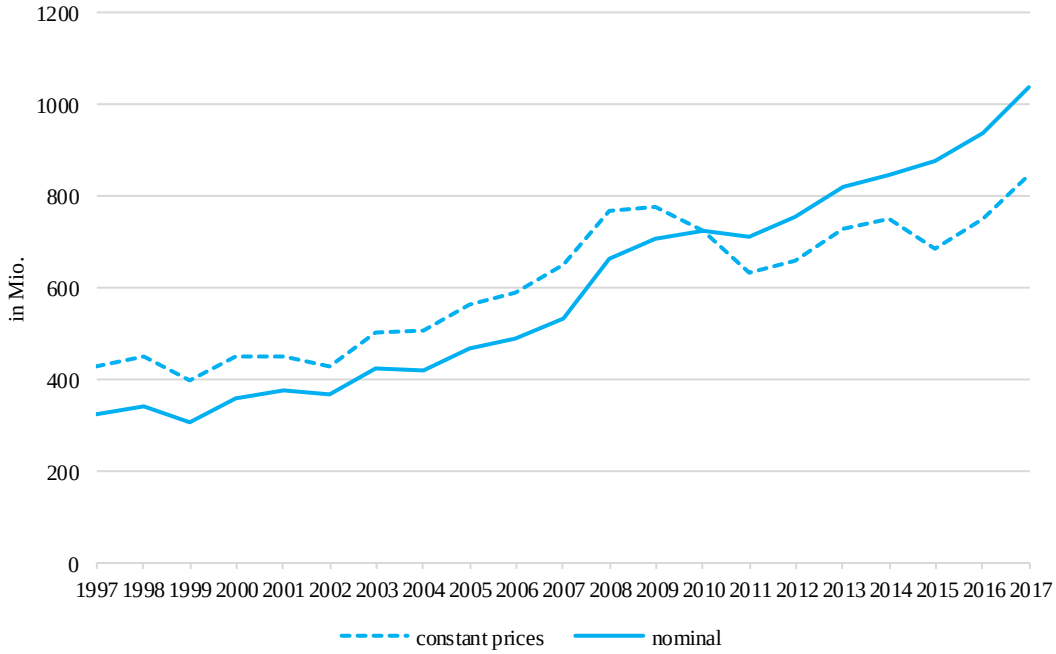
[2] **Panel:** The reviewers meet in person and compile a ranking of all reviewed applications.

3.5.5 Important changes over time

Changes at the level of the agency

- Changes in organisational structure: N/A
- Changes in overall funding levels: With some exceptions, particularly in the aftermath of the economic crisis 2008/9, the total funding awarded by the SNSF grew steadily over time.

Figure 14: SNSF awarded funding in current and constant CHF, 1997-2017

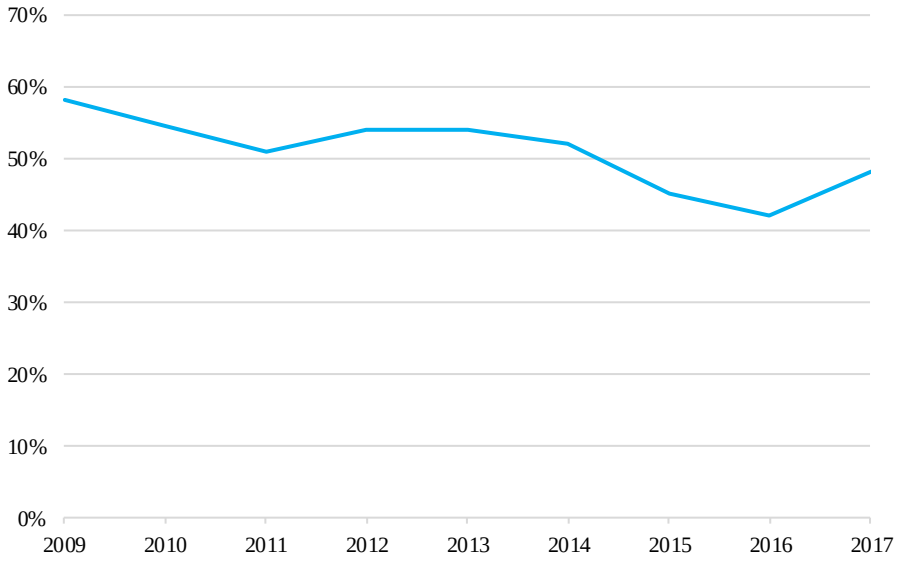


Source: SNSF Annual reports, AMECO database for BIP deflator (2010=100), WIFO calculation.

Changes at the level of the individual funding schemes

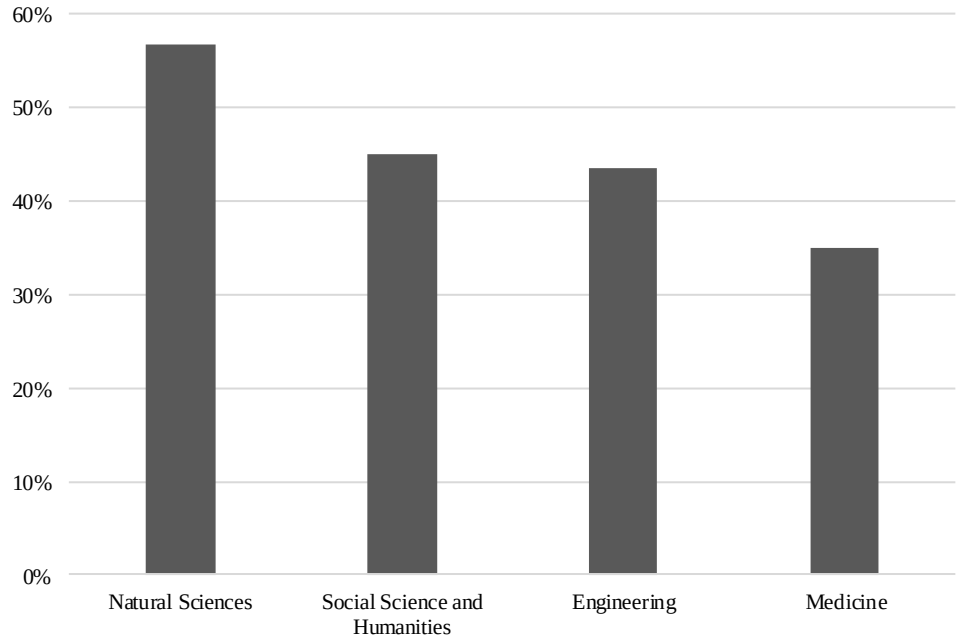
Success rates in single project funding have decreased from almost 60% in 2009 to just below 50% in 2017.

Figure 15: Success Rate in single project funding, 2009-2017



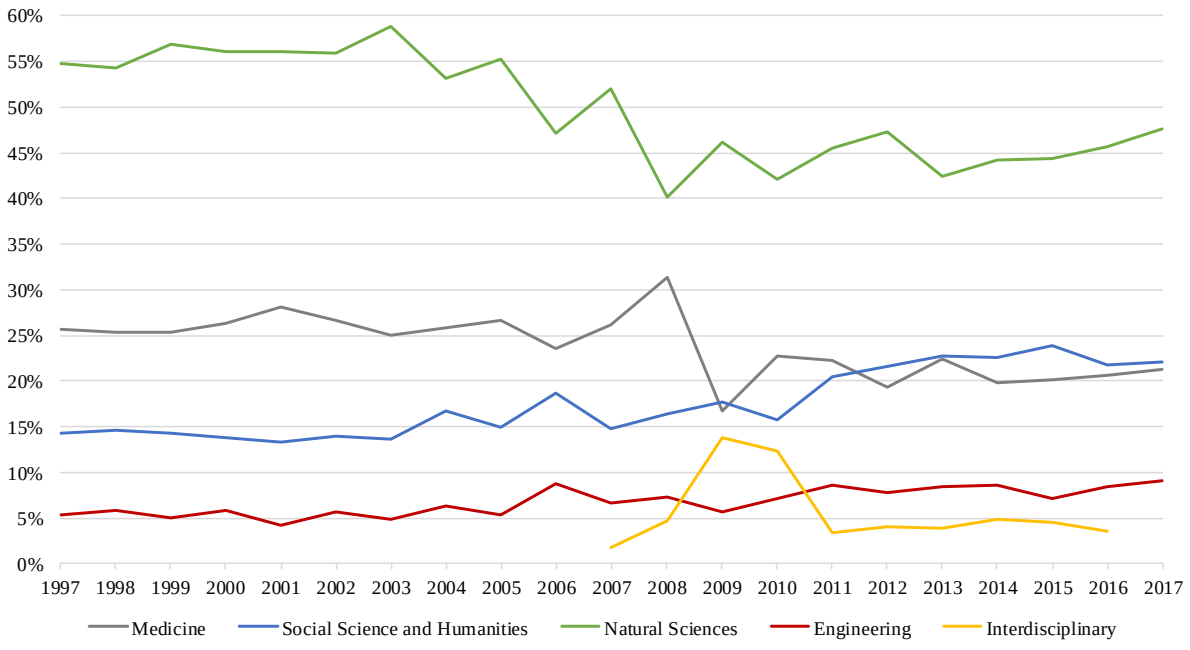
Source: SNSF Annual reports.

Figure 16: Success Rate in single project funding by discipline, 2017



Source: Data was provided by the SNSF. Note: Disciplines proposed by study authors.

Figure 17: Total awarded funding in Single project funding by discipline – Switzerland, 1997-2017



Source: SNSF Annual reports.

- Shifts in budget shares between schemes

The biggest trend in SNSF's funding portfolio is the declining share of single project funding and structural priority areas towards SPF early career, networks, mobility and translation.

Table 17: SNSF shares of funding instruments, average change in percentage points between 1997-2001 and 2014-2017

	Average share 2014-2017	Average change of share 1997-2001 to 2014-2017 in percentage points
Project funding	**60.2%**	**-7.0**
Single project funding (SPF)	49.1%	-18.1
SPF Early career	4.8%	+4.8
SPF high-risk	-	-
Networks and Multi-Project funding	6.2%	+6.2
Interdisciplinary research	-	-
Priority areas	**12.1%**	**-4.6**
Structural priority area	7.4%	-3.5
Thematic priority area	4.7%	-1.0
Infrastructure	**5.0%**	**+3.4**
Funding of people	**17.4%**	**+6.5**
Education & Training	1.2%	+1.2
Career	9.2%	-0.7
Diversification	0.7%	+0.3
Prizes	-	-
Mobility	6.3%	+5.7
International Cooperation	**1.4%**	**-0.7**
Translation	**2.5%**	**+1.6**
Applied Research	2.2%	+1.3
R&D Collaboration with firms	-	-
Commercialisation	0.3%	+0.3
R&D Value Chain	-	-
Scientific Communication	**0.8%**	**-0.1**

Source: SNSF Annual reports, WIFO calculation.

Over the whole period since 1997, the natural sciences and medicine have dropped as a share of total single project funding, while social sciences & humanities and engineering have increased from low levels. Interdisciplinary research was introduced as a category in 2007 and seems to have led to lower shares of medicine and natural sciences, in particular.

- Closure of funding schemes, introduction of new funding schemes:
  - Postdoc.Mobility (PM) fellowships replaced Advanced Postdoc.Mobility fellowships in Nov. 2017.
  - Ambizione Energy was a temporary funding measure within the scope of the Swiss Federal Council's Dispatch on the "Coordinated Swiss Energy Research" Action Plan.

- Assistant professor (AP) Energy grants was a temporary funding measure within the scope of the Swiss Federal Council's Dispatch on the "Coordinated Swiss Energy Research" Action Plan.
- The schemes "Scientific Conferences", "International Exploratory Workshops" and "International Short Visits" was replaced with a new scheme called "Scientific Exchanges" in 2017.
- The last Marie Heim-Vögtlin (MHV) call was in 2016. Since autumn 2017, a new funding scheme called PRIMA (Promoting Women in Academia) has replaced MHV.
- The SNSF stopped co-funding postgraduate courses at the end of 2015.
- The programme ProDoc was discontinued in 2012.
- The new SNSF Eccellenza scheme replaces SNSF Professorships starting 2018.

Source: http://www.snf.ch/en/funding/discontinued-funding-schemes/Pages/default.aspx.

Structural changes in allocation of funding (e.g. review procedures, overhead costs, etc.)

- Introduction of indirect cost rate "Overheadbeiträge" since 2009

3.5.6 Information and data sources

Contact at fund

Data Team of SNSF

datateam@snf.ch

Information about Project duration, Bottom-Up/Top-Down:

Funding schemes of SNSF, http://www.snf.ch/de/foerderung/Seiten/default.aspx.

Information about Success Rate, Budget funding, Lot size, etc.:

Annual reports of SNSF

- for 1997-2003: PDF copies sent by SNSF
- for 2004-2017:

  http://www.snf.ch/de/derSnf/portraet/zahlen_fakten/statistiken/Seiten/default.aspx#Statistiken%3A%20Archiv

Information about Young Investigators:

http://www.snf.ch/en/theSNSF/evaluation-procedures/careers/Pages/default.aspx#

Information about Project funding:

http://www.snf.ch/en/theSNSF/evaluation-procedures/project-funding/Pages/default.aspx

3.6 UK Research and Innovation (UKRI)

The UK has recently undergone major change with respect to its funding of science, with the hitherto 7 research councils being regrouped under a common umbrella organisation, UK Research and Innovation (UKRI), together with Research England and Innovate UK. In the following, we present features of both the umbrella organisation and the 7 research councils, providing separate information when there are differences in funding practices and consolidated information when all councils share the same practices, as e.g. in using full economic costing for reimbursing funds.

3.6.1 Organisational mission and structure

Mission focus

UKRI and the individual research councils follow a broad focus on both funding the creation of knowledge as well as its use, strongly emphasising economic and societal impact. Creation of knowledge is not limited to basic research, but explicitly as in the case of the EPSRC also includes strategic and applied research. The following information is taken from the UKRI website:

UKRI and the individual research councils follow a broad focus on both funding the creation of knowledge as well as its use, strongly emphasising economic and societal impact. Creation of knowledge is not limited to basic research, but explicitly as in the case of the EPSRC also includes strategic and applied research. The following information was taken from the UKRI's website:

UKRI's mission is to work with UKRI's partners to ensure that world-leading research and innovation continues to grow and flourish in the UK. UKRI will support and help to connect the best researchers and businesses. UKRI will invest every pound of taxpayers' money wisely in a way that generates excellent outcomes and ultimately impact for citizens, in the UK and across the world.

To achieve these goals, UKRI must ensure that the UK continues to provide the best environment for research and innovation. The UK research and innovation system consists of a wide range of organisations – universities, businesses, charities, public sector bodies, innovation and enterprise agencies.

- UKRI will push the frontiers of human knowledge and understanding.
- UKRI will deliver economic impact
- UKRI will create social and cultural impact by supporting society to become enriched, healthier, more resilient and sustainable.

UKRI will work closely in partnership with these organisations and with the devolved funding bodies; learning from them and strengthening the networks which underpin UKRI's world-leading position in research and innovation. UKRI will ensure that UK Research and Innovation continues to develop as an outstanding organisation.

Each of the nine Councils (AHRC, BBSRC, ESRC, EPSRC, Innovate UK, MRC, NERC, Research England, STFC) have Council members who are involved in strategy development and governance. Council members work with their Executive Chair to deliver their council's aims and objectives and to support UKRI's overall mission.

Source: https://www.ukri.org/about-us/strategic-prospectus/vision-mission-and-values/.

Table 18: Missions of the seven independent research councils

Council	Mission statement
Arts & Humanities Research Council (AHRC)	The Arts and Humanities Research Council aims to: • Promote and support the production of world-class research in the arts and humanities. • Promote and support world-class postgraduate training designed to equip graduates for research or other professional careers. • Strengthen the impact of arts and humanities research by encouraging researchers to disseminate and transfer knowledge to other contexts where it can make a difference. • Raise the profile of arts and humanities research and to be an effective advocate for its social, cultural and economic significance. Source: https://ahrc.ukri.org/about/policies/codeofpractice/ourmission/.
Biotechnology & Biological Sciences Research Council (BBSRC)	The BBSRC's mission is: • To promote and support, by any means, high-quality basic, strategic and applied research and related postgraduate training relating to the understanding and exploitation of biological systems. • To advance knowledge and technology (including the promotion and support of the exploitation of research outcomes), and provide trained scientists and engineers, which meet the needs of users and beneficiaries (including the agriculture, bioprocessing, chemical, food, healthcare, pharmaceutical and other biotechnological related industries), thereby contributing to the economic competitiveness of the United Kingdom and the quality of life. In relation to the Council's activities, and as the Council may see fit, to: • generate public awareness • communicate research outcomes • encourage public engagement and dialogue • disseminate knowledge. Source: https://bbsrc.ukri.org/about/vision-mission-strategy/mission-history/.
Engineering and Physical Sciences Research Council (EPSRC)	• Promote and support, by any means, high quality basic, strategic and applied research and related postgraduate training in engineering and the physical sciences. • Advance knowledge and technology (including the promotion and support of the exploitation of research outcomes), and provide trained scientists and engineers, which meet the needs of users and beneficiaries (including the chemical, communications, construction, electrical, electronic, energy, engineering, information technology, pharmaceutical, process and other industries), thereby contributing to the economic competitiveness of the United Kingdom and the quality of life. In relation to the activities above, as engaged in by the Council and in such manner as the Council may see fit, to:

Council	Mission statement
	• Generate public awareness • Communicate research outcomes • Encourage public engagement and dialogue • Disseminate knowledge • Provide advice Approximately half of all of EPSRC's research funding involves collaboration with industry (or other research users) and contributions from them either in case or kind. EPSRC also offers research funding. Source: https://epsrc.ukri.org/about/facts/mission/.
Economic and Social Research Council (ESRC)	The following information was taken from the ESRC's website: ESRC's mission is to: • promote and support, by any means, high-quality research and related postgraduate training on social and economic issues • develop and support the national data infrastructure that underpins high-quality research • advance knowledge and provide trained social scientists who meet the needs of users and beneficiaries, thereby contributing to the economic competitiveness of the UK, the effectiveness of public services and policy, and the quality of life • communicate clearly and promote public understanding of social science. Source: https://esrc.ukri.org/about-us/what-we-do/.
Medical Research Council (MRC)	The heart of MRC's mission is to improve human health through world-class medical research. To achieve this, *MRC* supports research across the biomedical spectrum, from fundamental lab-based science to clinical trials, and in all major disease areas. *MRC* works closely with the NHS and the UK Health Departments to deliver *its* mission, and give a high priority to research that is likely to make a real difference to clinical practice and the health of the population. The MRC's mission, as set out *in our Royal Charter*, is to: • encourage and support research to improve human health • produce skilled researchers • advance and disseminate knowledge and technology to improve the quality of life and economic competitiveness of the UK • promote dialogue with the public about medical research. Source: https://mrc.ukri.org/about/what-we-do/mission/.
Natural Environment Research Council (NERC)	NERC responsibilities as set out in the Higher Education & Research Act 2017 are to: • carry out research into environmental science, technology and new ideas • encourage and support the provision of postgraduate training in environmental science, technology and new ideas

Council	Mission statement
	• facilitate, encourage and support environmental research, technology and new ideas • facilitate, encourage and support the development and exploitation of environmental science, technology and new ideas • facilitate, encourage and support knowledge exchange in relation to environmental science, technology and new ideas • collect, disseminate and advance knowledge in environmental science, technology and new ideas • promote awareness and understanding of environmental science, technology and new ideas • provide advice on any matter relating to NERC functions • promote awareness and understanding of NERC activities. Source: https://nerc.ukri.org/about/whatwedo/vision/.
Science & Technology Facilities Council (STFC)	As set out in the Royal Charter which came into force on 1st April 2007 and established STFC as a Research Council and legal entity, its mission is to: • Promote and support high-quality scientific and engineering research by developing and providing, by any means, facilities and technical expertise in support of basic, strategic and applied research programmes funded by persons established in the UK and elsewhere. • Promote and support, by any means, high-quality basic, strategic and applied research and related postgraduate training in astronomy, particle physics, space science and nuclear physics and research in any other field which makes use of scientific facilities where access is provided, arranged or otherwise made available by STFC, having regard to the objectives of the other Research Councils. • Promote and support the advancement of knowledge and technology (including the promotion and support of the exploitation of research outcomes) and to provide trained scientists and engineers, and thereby to contribute to the economic competitiveness of the UK and the quality of life of its people, meeting the needs of users and beneficiaries. In relation to STFC's activities and as it may see fit: • generate public awareness • communicate research outcomes • encourage public engagement and dialogue • disseminate knowledge • provide advice This mission provides the underlying framework for our entire portfolio of operations and activities as we focus on delivering world-beating science and technology. Source: https://stfc.ukri.org/about-us/our-purpose-and-priorities/stfc-vision/.

Source: Websites indicated in second column.

Overarching decision structures

UKRI is set up as a governmental agency, rather than as academic self-governance, i.e. academic scientists have an advisory role rather than a formal say in Council-level decision making. The individual Research Councils have no separate legal entity. The following information is taken from the UKRI website:

UKRI's main governance bodies are the UK Research and Innovation Board and the Executive Committee which provides strategy advice to the Board and is the day-to-day coordinating body for UKRI executive activity.

The **UK Research and Innovation Board** plays a critical role in providing strategic direction and oversight, promoting the importance of UK science and innovation and supporting the senior leadership team

Members of the Board are appointed by the Secretary of State for Business, Energy and Industrial Strategy, typically serving for between three and five years in the first instance, with the possibility of an extension to their term. The Board is made up of the UK Research and Innovation Chair, Chief Executive, Chief Finance Officer and 9-12 independent members. The Board is responsible to the Secretary of State for achieving the UKRI strategic objectives and vision.

The **Executive Committee** provides strategy advice to the UKRI Board and is the day-to-day coordinating body for UKRI executive activity. Chaired by the UKRI Chief Executive, membership includes the nine Executive Chairs of the individual Councils (see below) and the Chief finance officer. It provides leadership to the organisation including across the collective activities of the separate Councils to ensure collaboration on strategy and operational matters.

The Executive Committee is supported by three sub-committees:

People, Finance and Operations Committee provides leadership for, and overseeing, collective areas of operational strategy and policy, chaired by the Chief Finance Office.

Strategy Committee provides expertise and advice on the development of and implementation of UKRI's research strategy, chaired by the Strategy Director. (The strategy committee will continue the work of the Research and Innovation Strategy and Funding Sub-Group

Investment Committee provides expertise, advice and assurance on major investment decisions, including assessment of business cases and the oversight of the portfolio of major projects across the organisation, chaired by the Chief Finance Office.

The executive sub-committees have delegated decision-making from the UKRI CEO (respecting principle of council subsidiarity and Executive chairs delegated responsibilities). The Chair of each committee can escalate areas of concern to the Executive Committee and may have sub-committees or groups that report into them (at their discretion).

Decision structures for funding

The formalization of the Haldane principle (page 60 in https://www.ukri.org/files/about/ukri-framework-document-2018-pdf/) means that the UK government formally rescinds any influence on individual funding decisions of projects. However, otherwise most funding decisions could be taken at the central UKRI level, while currently, the individual Research Councils still take most of the funding decisions, based on their peer review process (see section 3.5.4.).

Allocation of government funds to agency

In the future, central UKRI will be responsible for making a case for the combined UKRI budget to elected ministers. They are also responsible for providing advice to those ministers about the allocation of that budget to the nine councils of UKRI.

Organisation of funding activities

The Research Councils provide discipline-specific funding through funding schemes which invite both investigator-initiated projects ("responsive mode") and managed or programmed funding, i.e. the Councils also invite proposals for its own research questions. Most of the Research Councils feature a couple of core mechanisms, among them a general research grants scheme, i.e. the standard single-project funding, as well as

early career grant funding schemes, career development and postgraduate funding schemes; more translation- and thematic challenge-oriented schemes also feature in the portfolio of most Councils. The umbrella organisation UKRI does have funding schemes of its own https://www.ukri.org/funding/funding-opportunities/. Note that the standard project funding research grants scheme is usually quite flexible, in that it accommodates both responsive (bottom-up) and managed (top-down) calls for proposals, single- and multi-project proposals, R&D collaboration with firms (and hence both basic and applied research proposals, single- as well as interdisciplinary research (as long as the problem addressed loosely falls within the remit of one of the Councils, e.g. a biological research question in the case of the BBSRC). Some Councils also provide funding for strategic institutes (such as the BBSRC). Thematic focus changes with the various calls influenced by current scientific needs and problems. Accordingly, the tables below need to be interpreted bearing in mind within-scheme flexibility of addressing other goals.

Table 19: Qualitative overview table of funding portfolios, 2017

Fonds	*AHRC*	*BBSRC*	*EPSRC*	*ESRC*	*MRC*	*NERC*	*STFC*
Project funding							
Single project funding	x	x	x	x	x	x	x
SPF Early career	x	x	x		x		x
SPF high-risk				x	x		
Networks and Multi-Project funding	x	x	x	x	x		x
Interdisciplinary research	x	x	x	x	x	x	x
Priority areas							
Structural priority area		x	x		x	x	
Thematic priority area	x			x	x	x	x
Infrastructure		x		x		x	x
Funding of people							
Education & Training				x	x		
Career	x		x	x	x	x	
Diversification							
Prizes							
Mobility	x	x	x		x		
International Cooperation	x			x	x		
Translation							
Applied Research							
R&D Collaboration with firms		x	x		x		x
Commercialisation	x	x				x	
R&D Value Chain				x			
Scientific Communication	x			x	x	x	

Source: Annual reports and websites of Councils, as well as direct information from Councils. Note that no information was validated by AHRC, ESRC, NERC and STFC.

3.6.2 Overview of funding schemes

The following information is taken from the websites. Research topic origin: Proposal topic is investigator-initiated ("bottom-up") or proposed by science fund ("top-down")

Council	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Project funding							
Single Project funding (SPF)							
AHRC – Arts & Humanities Research Council	Research Grants - Standard	Single project funding	yes	bottom-up	Project	The Research Grants Schemes are intended to support well-defined research projects enabling individual researchers to collaborate with, and bring benefits to, other individuals and organisations through the conduct of research. This scheme is not intended to support individual scholarship.	https://ahrc.ukri.org/funding/apply-for-funding/current-opportunities/researchgrantsstandardroute/
EPSRC – Engineering & Physical Sciences Research Council	Standard Research	Single project funding	yes	bottom-up/top-down	Project	Standard Grants are very flexible, with the scale of projects supported ranging from small value, short term grants to multi-million pound research programmes. A wide variety of activities are supported, including feasibility studies, instrument development, equipment to support a number of research projects, overseas travel grants, and long-term proposals to develop or maintain critical mass	https://epsrc.ukri.org/funding/applicationprocess/routes/standardresearch/
ESRC - Economic and Social Research Council	Research Grants	Single project funding	yes	bottom-up/top-down	Project	The ESRC Research Grants (open call) invites proposals from eligible individuals and research teams for standard research projects, large-scale surveys and other infrastructure projects and for methodological developments. The call offers researchers considerable flexibility to focus on any subject area or topic providing that it falls within ESRC's remit.	https://esrc.ukri.org/funding/funding-opportunities/research-grants/
MRC - Medical Research Council	Research Grant	Single project funding	yes	bottom-up/top-down	Project	MRC research grants are suitable for focused research projects that may be short- or long-term in nature. In addition, they can be used to support method development or development and continuation of research facilities and may involve more than one research group or institution	https://mrc.ukri.org/funding/how-we-fund-research/research-grant/
NERC - Natural Environment Research Council	Standard grants	Single project funding	yes	bottom-up/top-down	Project	Standard grants support excellent research in response to unsolicited ideas from research groups, teams or individuals, in any area relevant to the remit of NERC.	https://nerc.ukri.org/funding/available/researchgrants/standard/
STFC - Science and Technology Facilities Council	Consolidated awards	Single project funding	yes	bottom-up/top-down	Project	Consolidated grants are awarded for a maximum of four years and only one application per department per research area is permitted.	https://stfc.ukri.org/research-grants-handbook/4-types-of-stfc-research-funding/#4.1.2
STFC - Science and Technology Facilities Council	Standard awards	Single project funding	yes	bottom-up/top-down	Project	Standard grants are awards that do not fit the criteria for Consolidated, Consortium or New Applicants awards. They are normally awarded for a period of up to three years although support for a specific project may be awarded for a longer period.	https://stfc.ukri.org/research-grants-handbook/4-types-of-stfc-research-funding/#4.1.2

Council	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
SPF Early career							
AHRC – Arts & Humanities Research Council	Research Grants - Early Careers	Single project funding early career	yes	bottom-up	Project	Intended to assist new researchers at the start of their careers in gaining experience of managing and leading research projects.	https://ahrc.ukri.org/funding/apply-for-funding/current-opportunities/researchgrantsearlycareers/
BBSRC – Biotechnology & Biological Sciences Research Council	New Investigator Scheme	Single project funding early career	yes	bottom-up	Project	The New Investigator scheme is a mechanism designed primarily to assist newly employed university lecturers, researchers in Research Council Institutes (at a level equivalent to lecturer), and fellows(at a level equivalent to lecturer) to secure their first major element of research support funding	https://bbsrc.ukri.org/documents/grants-guide/, p. 12
EPSRC – Engineering & Physical Sciences Research Council	New Investigator Award	Single project funding early career	yes	N/A	Person	The New Investigator Award scheme is to support individuals who have recently acquired their first academic lectureship position, have not previously led an academic research group or been the recipient of a significant grant	https://epsrc.ukri.org/funding/applicationprocess/routes/newac/nia/
ESRC - Economic and Social Research Council	New Investigator Award	Single project funding early career	yes	bottom-up	Project	We are pleased to invite proposals for our New Investigator Grants. New Investigator Grants form one element of our support for early career researchers and the scheme is specifically aimed at supporting those looking to make the transition to an independent researcher through managing their first major research project. These grants replace our Future Research Leaders scheme.	https://esrc.ukri.org/funding/funding-opportunities/new-investigator-grants/
MRC - Medical Research Council	New Investigator Research grant	Single project funding early career	yes	bottom-up	Project	The New Investigator Research Grant (NIRG) is aimed at researchers who are capable of becoming independent Principal Investigators and who are now ready to take the next step towards that goal.	https://mrc.ukri.org/funding/how-we-fund-research/new-investigator-research-grant/#who
STFC - Science and Technology Facilities Council	New applicant awards	Single project funding early career	yes	bottom-up	Project	The purpose of this is to provide new staff members with the opportunity to obtain research funding in advance of the next grant submission.	https://stfc.ukri.org/files/new-applicant-scheme/
SPF High Risk							
MRC - Medical Research Council	Biomedical Catalyst	Single project funding high risk	yes	bottom-up	Project	The Biomedical Catalyst (BMC) is a unique partnership between the MRC and Innovate UK, providing responsive and effective support to the most innovative life sciences opportunities regardless of scientific approach. The BMC aims to de-risk innovative science and commercialise ideas arising out of academia and industry helping UK SMEs to develop into competitive and sustainable organisations.	https://mrc.ukri.org/funding/science-areas/translation/biomedical-catalyst/
Networks and Multi-Project funding							
AHRC – Arts & Humanities Research Council	Research Networking Scheme	Networks and Multi-Project funding	yes	bottom-up	Project	Intended to support forums for discussion and exchange of ideas on themes, issues, or problems. The scheme aims to facilitate interactions between researchers and stakeholders through, for example, a short series of workshops, seminars, or networking activities.	https://ahrc.ukri.org/funding/apply-for-funding/current-opportunities/researchnetworking/

Council	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
BBSRC – Biotechnology & Biological Sciences Research Council	Joint Research Projects	Networks and Multi-Project funding	yes	bottom-up	Project	Joint research projects provide researchers from two or more eligible institutions with an opportunity to apply for resources and funding for the same research project with a view to undertaking specific areas of the research project at each institution.	https://bbsrc.ukri.org/documents/grants-guide/, p. 13
EPSRC – Engineering & Physical Sciences Research Council	Network grants	Networks and Multi-Project funding	yes	bottom-up	Project	Funding to bring together researchers, industry and other groups to develop collaborations through workshops, visits and part-time coordinators.	https://epsrc.ukri.org/funding/applicationprocess/routes/network/networks/
MRC - Medical Research Council	Partnership Grant	Networks and Multi-Project funding	yes	bottom-up	Project	Partnership grants provide core funds for one to five years to support partnerships between diverse groupings of researchers and can be used for infrastructure support, platform activities and for bringing together managed consortia or multidisciplinary collaborations.	https://mrc.ukri.org/funding/how-we-fund-research/partnership-grant/
STFC - Science and Technology Facilities Council	Consortium grants	Networks and Multi-Project funding	yes	bottom-up	Consortium/Project	Consortium grants are intended to support a programme of work carried out by more than one University Department or institution, with a common research programme (essentially it is a joint consolidated grant in that it allows support for one department per research area across multiple institutions.)	https://stfc.ukri.org/research-grants-handbook/4-types-of-stfc-research-funding/#4.1.2
STFC - Science and Technology Facilities Council	Joint Grants	Networks and Multi-Project funding	yes	bottom-up	Project	Joint grant awards are standard awards but are designed to fund research at more than one research organisation.	https://stfc.ukri.org/research-grants-handbook/4-types-of-stfc-research-funding/#4.1.2
Priority areas							
Structural priority area							
EPSRC – Engineering & Physical Sciences Research Council	Programme grant	Structural priority area	yes	bottom-up	Project	Programme Grants are a flexible mechanism to provide funding to world-leading research groups to address significant major research challenges. They are intended to support a variety of activities focussing on one strategic research theme.	https://epsrc.ukri.org/funding/applicationprocess/routes/capacity/programme/
MRC - Medical Research Council	Programme grant	Structural priority area	yes	bottom-up	Project	Programme grants provide larger, longer term (five years) and renewable programme funding. They aim to help the medical science community to 'think bigger'.	https://mrc.ukri.org/funding/how-we-fund-research/programme-grant/
NERC - Natural Environment Research Council	National capability funding	Structural priority area	yes	bottom-up	Project	NERC national capability lets the UK deliver world-leading environmental science, support national strategic needs, and respond to emergencies. It includes the research and development activities which keeps this capability at the cutting edge.	https://nerc.ukri.org/funding/available/nc-funding/
MRC - Medical Research Council	Centre grants	Structural priority area	yes	bottom-up	Project	MRC also funds Centre grants - high-profile centres of excellence with a clear strategic direction in areas of importance for UK medical research.	https://mrc.ukri.org/about/institutes-units-centres/what-are-institutes-units-and-centres/

Council	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Thematic priority area							
AHRC – Arts & Humanities Research Council	Global Challenges Research Fund	Thematic priority area	yes	top-down	Project	Collaboration and partnership with overseas researchers, governments, NGOs and other organisations is a core part of the GCRF and to ensuring that the research supported engages fully with relevant cultural and historic contexts, knowledge bases, creativity, languages, diverse voices and beliefs in LMICs.	https://ahrc.ukri.org/funding/internationalfunding/the-global-challenges-research-fund/
NERC - Natural Environment Research Council	Strategic research	Thematic priority area	yes	top-down	Project	NERC's strategic research funding supports research into environmental areas of major economic and societal importance. It aims to address key science challenges and priorities for the 21st century.	https://nerc.ukri.org/funding/available/programmes/
NERC - Natural Environment Research Council	Discovery science	Thematic priority area	yes	bottom-up	Project	NERC's discovery science (responsive mode) funding stream supports excellent environmental research that is driven by curiosity rather than by NERC's wider strategic priorities. Asking fundamental questions about how the world works often turns out to have wide-ranging social and economic benefits.	https://nerc.ukri.org/funding/available/researchgrants/
STFC - Science and Technology Facilities Council	Challenge Led Applied Systems Programme (CLASP) scheme	Thematic priority area	yes	bottom-up	Project	The Challenge Led Applied Systems Programme applies STFC research to global research challenges in the four key areas identified in the Futures Programme i.e. energy, environment, healthcare and security. Individual calls are aligned to specific challenge areas.	https://stfc.ukri.org/funding/working-with-industry/
Infrastructure							
BBSRC – Biotechnology & Biological Sciences Research Council	National facilities	Infrastructure	yes	bottom-up	Project	BSRC accepts applications requiring access to the High Performance Computing facilities at the University of Edinburgh (ARCHER) and the Earlham Institute.	https://bbsrc.ukri.org/documents/grants-guide/, p. 12
BBSRC – Biotechnology & Biological Sciences Research Council	Equipment	Infrastructure	yes	bottom-up	Project	Equipment may be sought as part of a grant application to the research Committees, where the items of equipment requested are necessary for the successful delivery of the proposed research.	https://bbsrc.ukri.org/documents/grants-guide/, p. 12
NERC - Natural Environment Research Council	Capital funding	Infrastructure	yes	bottom-up	Project	To maintain and strengthen the excellence and impact of UK environmental science, NERC needs to invest in new technologies, equipment, infrastructure, facilities and estates.	https://nerc.ukri.org/funding/available/capital/
STFC - Science and Technology Facilities Council	Access to Facilities	Infrastructure	yes	bottom-up	Project	STFC operates world-class large-scale research facilities and manages the UK access to large-scale facilities in other countries.	https://stfc.ukri.org/funding/access-to-facilities/
Funding of people							
Education & Training							
EPSRC – Engineering & Physical Sciences Research Council	Doctoral Training grants	Education & Training	yes	N/A	Person	EPSRC fund Doctoral Training at universities through Doctoral Training Grants, so do not provide funds directly to students.	https://epsrc.ukri.org/funding/applicationprocess/basics/eligibility/

Council	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
ESRC - Economic and Social Research Council	Associated Scholarships	Education & Training	yes	N/A	Person	Associated studentships, formerly known as grant-linked studentships, are designed to add value to the proposed research outlined in the grant proposal, whilst providing a clear opportunity for a distinct and independent course of enquiry for the student.	https://esrc.ukri.org/skills-and-careers/studentships/
MRC - Medical Research Council	Studentships	Education & Training	yes	N/A	Person	The MRC supports students by providing block grants and individual studentship awards, via competitions such as CASE, direct to ROs who then recruit and manage the students. We do not award grants directly to individual students.	https://mrc.ukri.org/funding/guidance-for-applicants/1-who-can-apply-and-how-to-apply/#1.6
STFC - Science and Technology Facilities Council	Fellowships	Education & Training	yes	N/A	Person	The STFC supports 10 different fellowships for researchers in different career stages.	https://stfc.ukri.org/funding/fellowships/
STFC - Science and Technology Facilities Council	Studentships	Education & Training	yes	N/A	Person	STFC postgraduate studentships are awarded to enable promising scientists and engineers to continue training beyond a first degree.	https://stfc.ukri.org/funding/studentships/
Career							
AHRC – Arts & Humanities Research Council	Leadership Fellows - Standard	Career	yes	bottom-up	Person	Opportunities for researchers and research organisations to work to increase leadership capacity and capabilities through programmes of development, training, and engagement.	https://ahrc.ukri.org/funding/apply-for-funding/current-opportunities/leadershipfellows/
AHRC – Arts & Humanities Research Council	Fellowships Scheme - Early Career	Career	yes	bottom-up	Person	Designed to build the capabilities of future leaders and equip individuals who have outstanding potential to develop the range of qualities they need to lead research agendas in the 21st century.	https://ahrc.ukri.org/funding/apply-for-funding/current-opportunities/leadershipfellowsecr/
AHRC – Arts & Humanities Research Council	Postgraduate Funding and Training (in Skills section)	Career	yes	N/A	N/A	We do not fund students directly, instead our postgraduate funding is provided to universities and they select and administer individual student awards. Prospective students should contact the institution at which they wish to study to enquire about the funding available.	https://ahrc.ukri.org/skills/phdstudents/post-graduate-funding-training/
EPSRC – Engineering & Physical Sciences Research Council	Postdoctoral	Career	yes	N/A	Person	The EPSRC Fellowship aims to provide greater support to the aspiring and current world-leading individuals who are delivering the highest quality research to meet UK and global priorities. Through links to our strategic priorities and focussing on areas where growth is required, Fellowships develop the next generation of researchers with the greatest potential across the postdoctoral, early and established career stages.	https://epsrc.ukri.org/skills/fellows/peerreviewprocess/whocanapply/
EPSRC – Engineering & Physical Sciences Research Council	Early	Career	yes	N/A	Person	The EPSRC Fellowship aims to provide greater support to the aspiring and current world-leading individuals who are delivering the highest quality research to meet UK and global priorities. Through links to our strategic priorities and focussing on areas where growth is required, Fellowships develop the next generation of researchers with the greatest potential across the postdoctoral, early and established career stages.	https://epsrc.ukri.org/skills/fellows/

Council	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
EPSRC – Engineering & Physical Sciences Research Council	Established	Career	yes	N/A	Person	The EPSRC Fellowship aims to provide greater support to the aspiring and current world-leading individuals who are delivering the highest quality research to meet UK and global priorities. Through links to our strategic priorities and focussing on areas where growth is required, Fellowships develop the next generation of researchers with the greatest potential across the postdoctoral, early and established career stages.	https://epsrc.ukri.org/skills/fellows/
NERC - Natural Environment Research Council	Postgraduate training	Career	yes	N/A	Person	In order to sustain the flow of top talent and skills for UK science, business and government, NERC provides two types of postgraduate training; Responsive and Focused PhD training	https://nerc.ukri.org/funding/available/postgrad/
NERC - Natural Environment Research Council	Fellowships	Career	yes	N/A	Person	The NERC fellowship scheme provides opportunities for outstanding early-career environmental scientists to devote their time to: - producing research of international importance - developing their research careers and research groups - developing into recognised science leaders.	https://nerc.ukri.org/funding/available/fellowships/
MRC - Medical Research Council	Fellowships	Career	yes	N/A	Person	MRC's fellowships support the development of talented individuals to strengthen the UK research base and enable the scientific community to respond effectively to current and future grand challenges in medical research	https://mrc.ukri.org/skills-careers/fellowships/
Prizes							
ESRC - Economic and Social Research Council	Celebrating Impact Prize	Prizes	yes	N/A	Person	The Celebrating Impact Prize, now in its sixth year, is an annual opportunity to recognise and reward ESRC-funded researchers and ESRC associates. It celebrates outstanding ESRC research and success in interdisciplinary, collaborative working, partnerships, engagement and knowledge exchange activities that have led to significant impact.	https://esrc.ukri.org/research/celebrating-impact-prize/
Mobility							
AHRC – Arts & Humanities Research Council	International Placement Scheme	Mobility	yes	N/A	Person	An annual programme providing Research Fellowships to AHRC/ESRC-funded doctoral students and early career researchers at a number of world leading international research institutions.	https://ahrc.ukri.org/funding/internationalfunding/international-placement-scheme/
BBSRC – Biotechnology & Biological Sciences Research Council	Money Follows Researchers	Mobility	yes	N/A	Person	The 'Money Follows Researchers' scheme allows researchers funded by a BBSRC grant to continue their funded research upon moving to another participating European country.	https://bbsrc.ukri.org/documents/grants-guide/, p. 16
EPSRC – Engineering & Physical Sciences Research Council	Overseas Travel Grants	Mobility	yes	N/A	Person	Overseas Travel Grants (OTGs) provide funding for international travel and subsistence to study new techniques at recognised centres outside the UK, and for travel to start or develop international collaborations.	https://epsrc.ukri.org/funding/applicationprocess/routes/international/otgs/

Council	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
MRC - Medical Research Council	Money Follows Researchers	Mobility	yes	N/A	Person	The Money Follows Researchers scheme allows researchers funded by an MRC grant to continue their funded research upon moving to another participating European country. The grant can then be continued at the new research institution within the original terms and objectives.	https://mrc.ukri.org/funding/science-areas/international-and-global-health-research/subscriptions-partnerships/other-international-funding-activities/
International Cooperation							
AHRC – Arts & Humanities Research Council	Newton Fund	International Cooperation	yes	top-down	Project	This initiative aims to strengthen research and innovation partnerships to promote economic development and social welfare of partner countries.	https://ahrc.ukri.org/funding/internationalfunding/newton-fund/
AHRC – Arts & Humanities Research Council	Humanities in the European Research Area (HERA)	International Cooperation	yes	top-down	Project	Humanities in the European Research Area (HERA) is a network of national funding agencies committed to leading and developing funding opportunities for humanities researchers in Europe, and sharing excellence in research management practices and outcomes	https://ahrc.ukri.org/funding/internationalfunding/hera/
AHRC – Arts & Humanities Research Council	EU-India Platform for the Social Sciences and Humanities (EqUIP)	International Cooperation	yes	top-down	Project	A partnership between research funding agencies in Europe and India.	https://ahrc.ukri.org/funding/internationalfunding/eu-india-platform-for-the-social-sciences-and-humanities-equip/
AHRC – Arts & Humanities Research Council	Lead agency and reciprocal agreements	International Cooperation	yes	top-down	Project	The AHRC has co-funding agreements with non-UK funding organisations in Brazil, USA, Norway and Switzerland. These enable joint research projects which can be applied for under a single grant application.	https://ahrc.ukri.org/funding/internationalfunding/lead-agency-and-reciprocal-agreements/
BBSRC – Biotechnology & Biological Sciences Research Council	Support for international activity	International Cooperation	yes	bottom-up	Project	BBSRC promotes international links to exploit new scientific opportunities, and to explore ways of sharing knowledge for mutual benefit.	https://bbsrc.ukri.org/documents/grants-guide/, p. 15
MRC - Medical Research Council	Newton Fund	International Cooperation	yes	top-down	Project	This initiative aims to strengthen research and innovation partnerships to promote economic development and social welfare of partner countries.	https://mrc.ukri.org/funding/science-areas/international-and-global-health-research/the-newton-fund/
MRC - Medical Research Council	International and global health research	International Cooperation	yes	top-down	Project	The aim of the MRC's International research is to provide international leadership in partnerships which enhance the competitiveness of the UK knowledge and health base and to influence the international research agenda.	https://mrc.ukri.org/funding/science-areas/international-and-global-health-research/
Translation							
R&D Collaboration with firms							
BBSRC – Biotechnology & Biological Sciences Research Council	Industrial Partnership Awards	R&D Collaboration with firms	yes	bottom-up	Project	Standard peer-reviewed research grants, but with financial support from industrial partners.	https://bbsrc.ukri.org/documents/grants-guide/, p. 8f

Council	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
BBSRC – Biotechnology & Biological Sciences Research Council	Stand-Alone LINK	R&D Collaboration with firms	yes	bottom-up	Project	pre -competitive research, funded 50:50 with industrial partners.	https://bbsrc.ukri.org/documents/grants-guide/, p. 10
BBSRC – Biotechnology & Biological Sciences Research Council	Working with business	R&D Collaboration with firms	yes	bottom-up	Project	BSRC works with industry, government and others to harness business opportunities and deliver economic impact from the research we fund as quickly as possible.	https://bbsrc.ukri.org/documents/grants-guide/, p. 16
EPSRC – Engineering & Physical Sciences Research Council	Collaboration opportunities for business	R&D Collaboration with firms	yes	bottom-up	Project	EPSRC only funds research and training in universities, but strongly encourages academic researchers to collaborate with partners in developing their ideas where this can deliver high-quality academic research.	https://epsrc.ukri.org/innovation/business/opportunities/
ESRC - Economic and Social Research Council	Opportunities for business	R&D Collaboration with firms	yes		Project	The social sciences have a great deal to offer businesses – from understanding the potential for new goods, services and business models to improving relationships with providers, customers and employees. ESRC therefore offers different programs for the collaboration with firms.	https://esrc.ukri.org/collaboration/opportunities-for-business/
STFC - Science and Technology Facilities Council	Collaborative Awards in Science and Engineering (CASE)	R&D Collaboration with firms	yes	bottom-up	Project	STFC works with industry and others to harness business opportunities with the aim of delivering economic impact from the research and capabilities STFC funds. This can be in the form of investing in collaborative research as well as research training with industrial partners.	https://stfc.ukri.org/funding/working-with-industry/
STFC - Science and Technology Facilities Council	Project Research and Development (PRD)	R&D Collaboration with firms	yes	bottom-up	Project	The PRD scheme is intended to develop the capabilities needed to underpin UK science and technology leadership in future Science and Technology Facility Council projects. The scheme provides funding for research and development projects which enable STFC to deliver the science programme objectives in the areas of particle physics, particle astrophysics, nuclear physics and astronomy.	https://stfc.ukri.org/funding/working-with-industry/project-research-and-development-scheme/
MRC - Medical Research Council	Proximity to Discovery: Industry Engagement Fund	R&D Collaboration with firms	yes	bottom-up	Project	Proximity to Discovery: Industry Engagement Fund is designed to provide flexible funding for innovative ways to enable the initial development of academic-industry collaborations.	https://mrc.ukri.org/funding/browse/industry-engagement-fund-parent/proximity-to-discovery-industry-engagement-fund-2017/
MRC - Medical Research Council	MRC Industry Collaboration Agreement (MICA)	R&D Collaboration with firms	yes	bottom-up	Project	The MRC Industry Collaboration Agreement (MICA) encourages and supports collaborative research projects between academic and industry researchers. It is an agreement between the commercial and academic partners to undertake collaborative research	https://mrc.ukri.org/innovation/mrc-industry-collaboration-agreement-mica/
Commercialisation							
BBSRC – Biotechnology & Biological Sciences Research Council	Follow-on Fund (FoF)	Commercialisation	yes	bottom-up	Project	The Follow-on funding programme is designed to support the translation of fundamental research funded by the Council into practical application, including commercialisation. The aim of the programme is to help researchers maximise the societal and economic benefits of their research.	https://bbsrc.ukri.org/documents/grants-guide/, p. 12

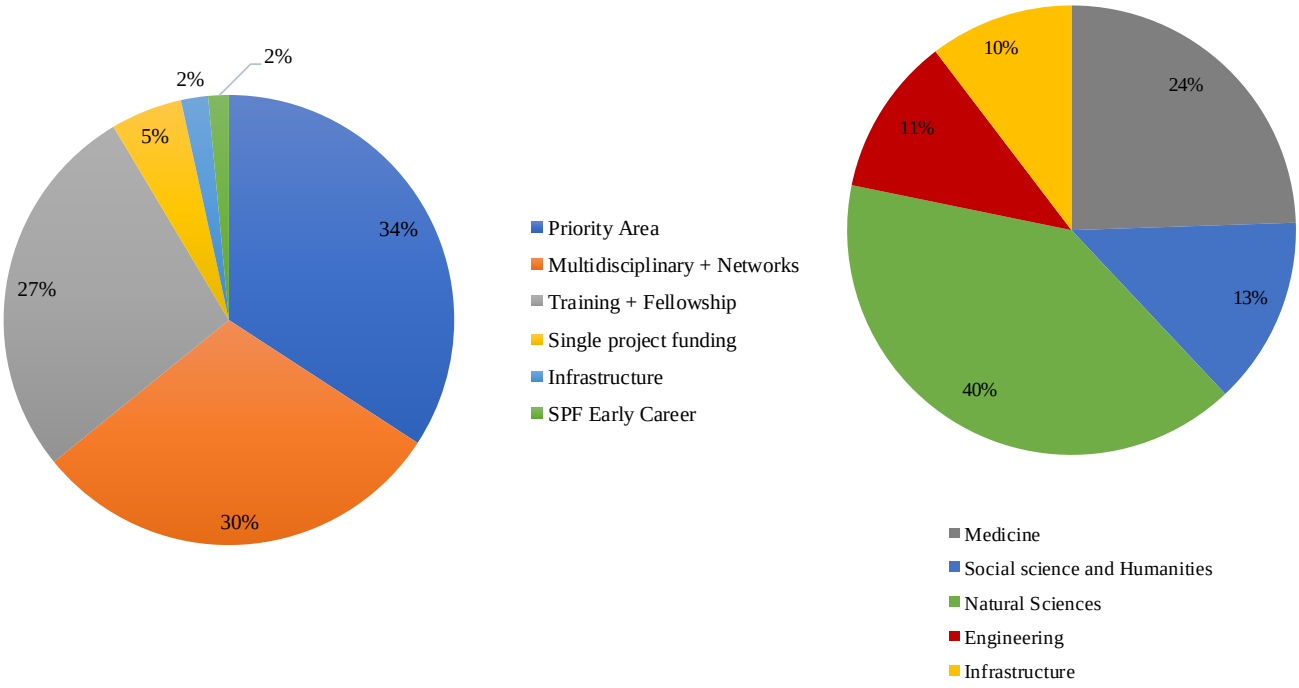
Council	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
STFC - Science and Technology Facilities Council	Innovation Partnership Scheme (IPS)	Commercialisation	yes	bottom-up	Project	The Innovations Partnership Scheme (IPS) is designed to transfer technology and expertise developed through STFC funding to the marketplace in partnership with industry and other academic disciplines. STFC technology or expertise must be integral to the project. The technology or expertise can be developed with STFC funding at UK higher education institutes, STFC laboratories, CERN, ESRF and ESO (European Southern Observatory).	https://stfc.ukri.org/funding/working-with-industry/
STFC - Science and Technology Facilities Council	IPS Fellowships	Commercialisation	yes	bottom-up	Project	The IPS fellowship is a scheme designed to support a role to develop the commercial exploitation of technologies. This is not a research orientated fellowship.	https://stfc.ukri.org/funding/working-with-industry/
STFC - Science and Technology Facilities Council	Knowledge Transfer Partnerships (KTP)	Commercialisation	yes	bottom-up	Project	Knowledge Transfer Partnerships supports UK businesses wanting to improve their competitiveness, productivity and performance by accessing the knowledge and expertise available within UK Universities.	https://stfc.ukri.org/funding/working-with-industry/
STFC - Science and Technology Facilities Council	Commercialisation	Commercialisation	yes	bottom-up	Project	We help researchers to explore the commercial potential of their research, to acquire business skills to develop it, and to take it towards commercialisation.	https://stfc.ukri.org/funding/working-with-industry/
AHRC – Arts & Humanities Research Council	Follow-on Funding for Impact and Engagement	Commercialisation & Science Communication	yes	bottom-up	Project	The AHRC Follow-on Funding for Impact and Engagement Scheme (FoF) provides funds to support innovative and creative engagements with new audiences and user communities which stimulate pathways to impact.	https://ahrc.ukri.org/funding/apply-for-funding/current-opportunities/followonfunding/
NERC - Natural Environment Research Council	Knowledge Exchange Fellowships	Commercialisation & Science Communication	yes	bottom-up	Project	NERC doesn't only fund science; it also helps turn that science into action, connecting researchers with those who can put their knowledge and skills to use, whether in industry, government or the third sector. Our knowledge exchange (KE) schemes provide an array of ways to support this flow of ideas and expertise.	https://nerc.ukri.org/funding/available/schemes/kefellows/
MRC - Medical Research Council	Confidence in Concept scheme 2017	Commercialisation	yes	bottom-up	Institution	Ensuring that fundamental science is translated into new therapies, diagnostics and medical devices is central to our mission. The Confidence in Concept scheme aims to accelerate the transition from discovery science to the early stages of therapeutic/biomarker development by providing locally-administered, responsive and flexible funding to support preliminary translational work	https://mrc.ukri.org/funding/browse/confidence-in-concept-scheme-parent/confidence-in-concept-scheme-2017/
Scientific Communication							
MRC - Medical Research Council	Public engagement funding	Scientific Communication	yes	bottom-up	Project	Effective public engagement is a key part of the MRC's mission and all MRC-funded establishments are encouraged to dedicate resources to support this area of work.	https://mrc.ukri.org/research/public-engagement/public-engagement-funding/

Source: Content of funding schemes: see column link and application documents of funding schemes. Bottom-up/top-down is assessment by WIFO based on the online description of the funding schemes and the application documents.

3.6.3 Characteristics of funding schemes

Similar to the Netherlands, the financial information on the Research Councils' funding schemes does not match the information provided on funding schemes for potential applicants. A detailed picture of the shares of individual funding schemes in total awarded funding is hence not available, the UK Research Councils usually do not track the spending information at such a detailed level. We did get detailed information from EPSRC on the share of various funding schemes. This shows that standard, curiosity-driven single project-funding is actually very low, and that thematic focus research as well as multi-project funding dominates. R&D collaboration with firms is not shown, as it can happen in most of the grant schemes and would hence be double counting; according to the EPSRC, in 2016/7 more than 50% of projects were collaborative with "users". EPSRC also provided information on the share of responsive (curiosity-driven, bottom-up) vs managed (top-down), which was at 58 to 42% in the most recent year. BBSRC provided data for the split in the standard research grants category for the funding year 2017/18: 58% (responsive mode) and 42% (managed mode initiative grants).

Figure 18: Share of programs in EPSRC (left panel) and share of disciplines in total awarded funding for all UK agencies (right panel), 2016



Source: Annual report of UK councils, WIFO calculation Note: Program shares for left panel have been calculated by EPSRC. The discipline shares are the total awarded funding amount of the following councils: Medicine: MRC; Social Sciences and Humanities: AHRC, ESRC, Natural Sciences: BBSRC, NERC and part of EPSRC; Engineering: part of EPSRC, Infrastructure: STFC. EPSRC provided special data to be able to split its funding according to disciplines.

The table below is mainly interesting for the information on success rates, as well as lot sizes and funding duration. The share of funding schemes in total awarded funding needs to be interpreted with care, as it does not always reflect the full complexity of the agencies' activities. Accordingly, and due to the flexibility of the standard Research Grants scheme, we classify it using the broader "Project funding" category rather than the single project funding scheme.

Table 20: Selected characteristics of the funding schemes, 2016, United Kingdom

Funding scheme according to study scheme classification	Original fund name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success rate
AHRC - Arts & Humanities Research Council							
Total		**100%**	**N/A**	**N/A**	**N/A**	**N/A**	**33%**
Project funding		**80%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Single project funding (SPF)	Research Grants (Standard)	45%	0.6-1.2 Mio. EUR	0.64	5 Years	N/A	25%
SPF Early career	Research Grants (Early Career)	5%	0.05-0.3 Mio. EUR	0.22	5 Years	N/A	55%
Interdisciplinary research	Thematic Calls	30%	0.034 Mio. EUR	0.4	N/A	N/A	41%
Funding of people		**14%**	**0.05-0.3 Mio. EUR**	**N/A**	**N/A**	**N/A**	**N/A**
Education & Training	Fellowships - Early Career	4%	0.05-0.3 Mio. EUR	0.17	6-24 months	N/A	28%
Career	Fellowships	9%	0.05-0.3 Mio. EUR	0.34	6-18 months	N/A	38%
Scientific Communication		**7%**	**N/A**	**0.06**	**N/A**	**N/A**	**N/A**
	Follow-on Funding - I&E	4%	0.12 Mio. EUR	0.08	12 months	N/A	43%
	Research Networking	3%	0.04 Mio. EUR	0.04	N/A	N/A	35%
BBSRC - Biotechnology & Biological Sciences Research Council							
Total		**100%**	**N/A**	**10.41**	**N/A**	**N/A**	**24%**
Project funding	**Research Grants**	**56%**	**2.2 Mio. EUR**	**N/A**	**max. 5 Years**	**N/A**	**N/A**
Single project funding (SPF)	Managed	22%	2.2 Mio. EUR	N/A	max. 5 Years	N/A	N/A
Single project funding (SPF)	Responsive	34%	2.2 Mio. EUR	N/A	max. 5 Years	N/A	N/A
Priority areas		**15%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Structural priority area	Strategic Institute	15%	N/A	N/A	N/A	N/A	N/A
Funding of people		**12%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Career		12%	N/A	N/A	N/A	N/A	N/A
	Fellowships/Studentships	12%	N/A	N/A	N/A	N/A	N/A
Infrastructure	**Capital Research Grants**	**14%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Translation		**2%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
R&D Collaboration with firms	Research industry clubs	2%	N/A	N/A	N/A	N/A	N/A
EPSRC - Engineering & Physical Sciences Research Council							
Total		**100%**	**N/A**	**N/A**	**N/A**	**N/A**	**29%**
Project funding		**100%**	**N/A**	**0.98**	**N/A**	**N/A**	**29%**
Single project funding (SPF)		100%	N/A	0.98	N/A	N/A	29%
	Managed	42%	N/A	2.17	N/A	N/A	34%
	Responsive	58%	not limited	0.70	not limited	N/A	28%
ESRC - Economic & Social Research Council							
Total	-	**100%**	**N/A**	**1.13**	**N/A**	**N/A**	**23%**
Project funding	**Responsive**	**14%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Single project funding (SPF)	Responsive	14%	0.4-1.2 Mio EUR	N/A	N/A	N/A	N/A
Priority areas	**Strategic & Collaborative**	**21%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Structural priority area	Strategic & Collaborative	21%	N/A	N/A	N/A	N/A	N/A
Infrastructure	**Methods & Infrastructure**	**15%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Funding of people		**41%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Education & Training		22%	N/A	N/A	N/A	N/A	N/A

	Training & Skills	5%	N/A	N/A	N/A	N/A	N/A
	Training & Skills	17%	N/A	N/A	N/A	N/A	N/A
Career		19%	N/A	N/A	N/A	N/A	N/A
	Postgraduate Awards	18%	N/A	N/A	N/A	N/A	N/A
	Newton & Other	0%	N/A	N/A	N/A	N/A	N/A
	Research Fellowships	1%	N/A	N/A	N/A	N/A	N/A
	Responsive	0%	N/A	N/A	N/A	N/A	N/A
	Strategic & Collaborative	1%	N/A	N/A	N/A	N/A	N/A
	Training & Skills	0%	N/A	N/A	N/A	N/A	N/A
International Cooperation		**4%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
	International & Others	1%	N/A	N/A	N/A	N/A	N/A
	Newton & Other	3%	N/A	N/A	N/A	N/A	N/A
Translation	**Knowledge & Exchange**	**4%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
R&D Collaboration with firms	Knowledge & Exchange	4%	N/A	N/A	N/A	N/A	N/A
MRC - Medical Research Council							
Total		**100%**	**N/A**	**1.71**	**N/A**	**N/A**	**23%**
Project funding		**52%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Single project funding (SPF)		52%	N/A	N/A	5 Years	N/A	22%
	Research Grant	52%	> 1.2 Mio. EUR	N/A	5 Years	N/A	22%
SPF Early career	New Investigator Research grant	N/A	N/A	N/A	3 years	N/A	24%
Networks and Multi-Project funding	Partnership Grant	N/A	N/A	N/A	5 Years	N/A	14%
Priority areas		**37%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Structural priority area		N/A	N/A	N/A	N/A	N/A	N/A
	Programme grant	N/A	N/A	N/A	5 Years	N/A	34%
	Centre grants	N/A	N/A	N/A	N/A	N/A	67%
	Other research	37%	N/A	N/A	N/A	N/A	N/A
Funding of people		**11%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Education & Training	Studentships	5%	N/A	N/A	N/A	N/A	86%
Career	Post-doctoral fellowships	7%	N/A	N/A	N/A	N/A	18%
NERC - Natural Environment Research Council							
Total		**100%**	**N/A**	**N/A**	**N/A**	**N/A**	**31%**
Project funding	**Research grants**	**65%**	**0.98**	**N/A**	**N/A**	**N/A**	**N/A**
Single project funding (SPF)	Research grants	65%	0.98	N/A	N/A	N/A	N/A
Priority areas	**Research contracts**	**21%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Structural priority area	Research contracts	21%	N/A	N/A	N/A	N/A	N/A
Funding of people	**Post graduate training award**	**14%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Career	Post graduate training award	14%	N/A	N/A	N/A	N/A	N/A
STFC - Science & Technology Facilities Council							
Total		**100%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Project funding	**Research grants**	**39%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Single project funding (SPF)	Research grants	39%	N/A	N/A	N/A	N/A	N/A
Infrastructure	**Contribution to construction of facilities**	**20%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Funding of people	**Post graduate training awards and fellowships**	**9%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Career	Post graduate training awards and fellowships	9%	N/A	N/A	N/A	N/A	N/A
Translation	**Joint Venture funding**	**19%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Commercialisation	Joint Venture funding	19%	N/A	N/A	N/A	N/A	N/A

Source: Annual reports of research councils, data for EPSRC for 2017 were provided by the agency. WIFO calculation.

Note that research grants usually accept renewal applications, they enter competitions the same way as first-time applications. However, no data exists on whether success rates are higher for renewal applications.

3.6.4 Refundable costs and review procedures of single project funding

Cost reimbursement is generally treated in the same way across the various Research Councils.

Cost of research time of principal investigator (MRC also funds wages of non-scientific staff e.g. project managers).

The following costs will be refunded:

- Wages of scientific/ technical staff
- Material expenses (i.e. Costs for equipment and materials of permanent value, direct costs for the use of infrastructures (including costs for maintenance and care), consumables, field expenses, computing time and data (cloud computing), costs for making research data accessible (open research data).
- Mobility (Travel (incl. accommodation and catering costs), conferences and workshops.)
- Costs of scientific (open access) publications. (MRC does not fund this in standard research grant)
- Administrative costs

Since 2006, the UK Research Councils fund research on the basis of full economic costing (FEC). The following description is taken directly from the UKRI's web page: "The principle behind FEC funding is that Research Organisations should indicate in their grant proposals the full economic cost of a project. Research Councils then pay a fixed percentage (80% for most fund headings) of this sum, which includes an attribution of the cost of academic staff time, and the institution's facilities, estates & indirect costs. This helps institutions to understand the full costs of the research they carry out and supports their research activities on a sustainable basis, with appropriate investment in research infrastructure, including buildings, facilities, and staff. Research organisations, in accepting an FEC grant, undertake to provide the remaining 20% from their own resources."

Source: https://www.ukri.org/files/legacy/documents/fecfaq-pdf/.

- Review Process

There is a UKRI Peer Review Framework which describes how peer review is used in assessing proposals and making funding decisions. The framework also outlines what information is routinely published relating to proposals and awards, and the approach taken by the councils in responding to requests for information about the assessment process. The framework is designed for use by Applicants and Research Organisations, Board/Panel members and external reviewers, members of the public and Research Council staff. In the following, we show however only the peer review process of EPSRC, for a standard grant. The peer review process of other Councils is similar, e.g. the MRC also features a two stage procedure with external peer review in the first and triage (prioritisation) of applications in the second through panels, in preparation of the funding meeting; criteria are also similar, while of course reflecting disciplinary differences (importance; scientific potential (research quality; research environment and people – how suitable are the applicant/her work environment; impact; ethics); appropriateness of resources requested)

Table 21: Overview of review process for full research proposal for standard grant at EPSRC

The following information is taken from the EPSRC website:

Internal/External reviewers:	External reviewers
Number of reviewers (per proposal):	Minimum 4 will be approached, minimum 3 needed in practice
International/National reviewers:	both
Organisation of Review:	**1st stage: EPSRC Portfolio Manager organises mail review** by external reviewers (possibly members of EPSRC Peer Review College, which consists of 5,500 independent experts, aiming at a balanced composition in terms of gender, region, etc.), **2nd stage: panel review** by panel review members –

	different to first stage reviewers, but also taken from Peer Review College if possible (prioritisation among projects reviewed in first stage, then recommendation for funding decision.; assessment of relative quality based on research quality and then on importance (see below)
Assessment criteria (incl. weights or relative importance, if available):	Primary major criterion: Quality 1) The novelty, relationship to the context, and timeliness; (2) The ambition, adventure, and transformative aspects identified; (3) The appropriateness of the proposed methodology. Secondary major criterion: Importance – how the research… (1) Contributes to, or helps maintain the health of other disciplines contributes to addressing key UK societal challenges and/or contributes to future UK economic success and development of emerging industry(s); (2) Meets national needs by establishing/maintaining a unique world leading activity; (3) Complements other UK research funded in the area, including any relationship to the EPSRC portfolio Secondary criterion: Impact. - particularly: (1) How complete and realistic are the impacts identified for this work; (2) The effectiveness of the activities identified to help realise these impacts, including the resources requested for this purpose; (3) The relevance and appropriateness of any beneficiaries or collaborators Secondary criterion: Applicant. - particularly 1) Appropriateness of the track record of the applicant(s); (2) Balance of skills of the project team, including academic partners **Secondary criterion: Resources and Management**. – assessment of: effectiveness of the proposed planning and management and of whether the requested resources are appropriate and have been fully justified; the viability of the arrangements described to access equipment needed for this project, and particularly on any university or third party contribution
Assessment criteria for early stage researchers (first-time applicants)	There are no specific criteria for early stage researchers in the standard grant, but EPSRC has a dedicated new investigator award.

Source: https://epsrc.ukri.org/funding/assessmentprocess/review/formsandguidancenotes/standardgrants/.

3.6.5 Important changes over time

Changes at the level of the agency

- Changes in organisational structure:

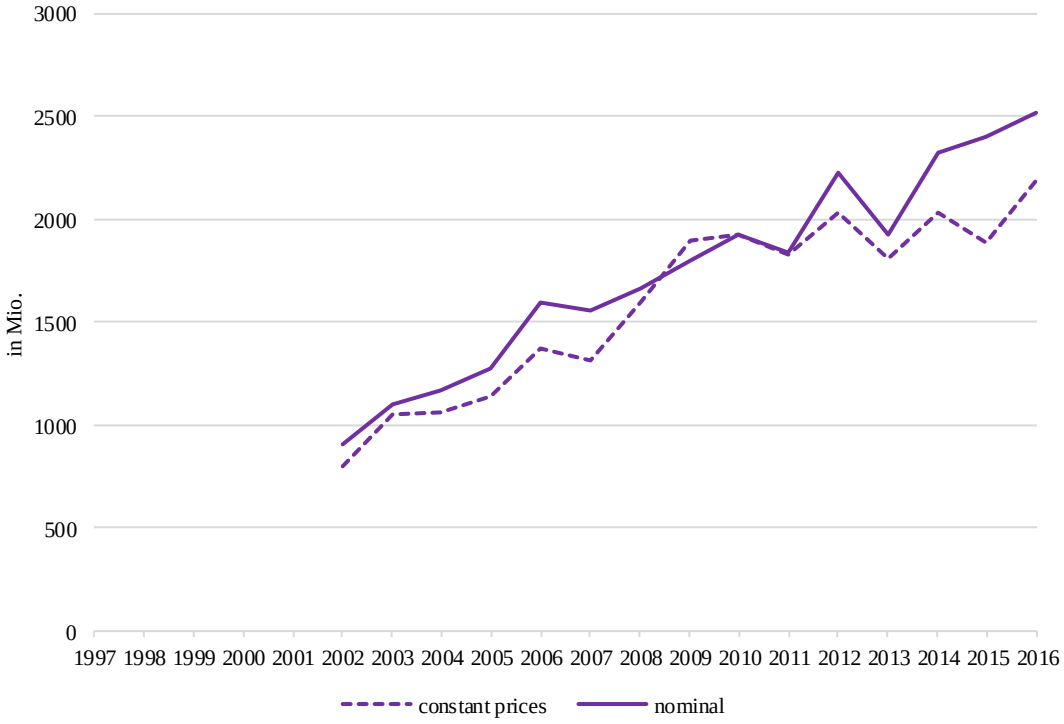
Most recently, merger of individual research councils to UKRI; In 2002 Research Councils UK was created as a secretariat in order to bring together the Research Councils at a higher level to work together more effectively; in 2005 the Arts and Humanities Research Council (AHRC) was established in order to bring research funding in the arts and humanities into line with that for other disciplines. It was created from the former Arts and Humanities Research Board.

In April 2007 PPARC (the Particle Physics and Astronomy Research Council) and CCLRC (Council for the Central Laboratory of the Research Councils) were combined to form the Science and Technology Facilities Council (STFC) to create a single Research Council which provides access for UK scientists to national and international research facilities.

- Changes in overall funding levels: Budget doubled since 2002.

Total disbursements by the UK Research Councils achieved steady increases over the years.

Figure 19: UK research councils total awarded funding in million pounds, 2002-2016

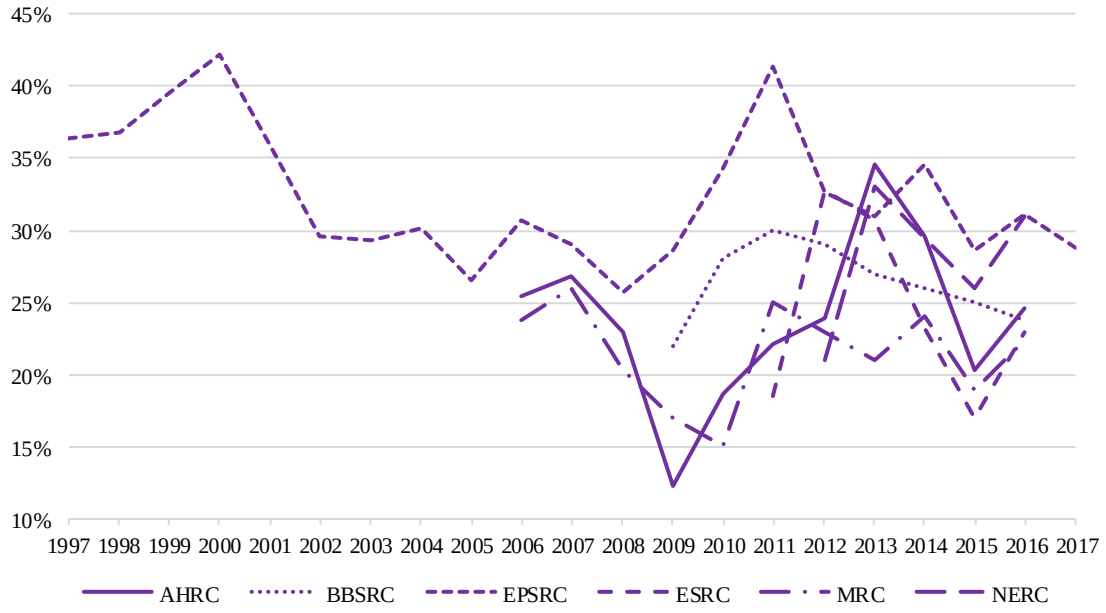


Source: Annual reports of councils, AMECO database for GDP deflator (2010=100), WIFO calculation.

Changes at the level of the individual funding schemes

Success rates vary quite strongly over the years and between the research councils, although there does seem to be a common pattern of change, reflecting some common budget-setting process. They are highest for the EPSRC and NERC at about 30%, and at about 23-25% for the other Research Councils.

Figure 20: Success rate in Single project funding, 1997-2017



Source: Annual reports of councils. Note: No success rates for STFC.

- Shifts in budget shares between schemes:

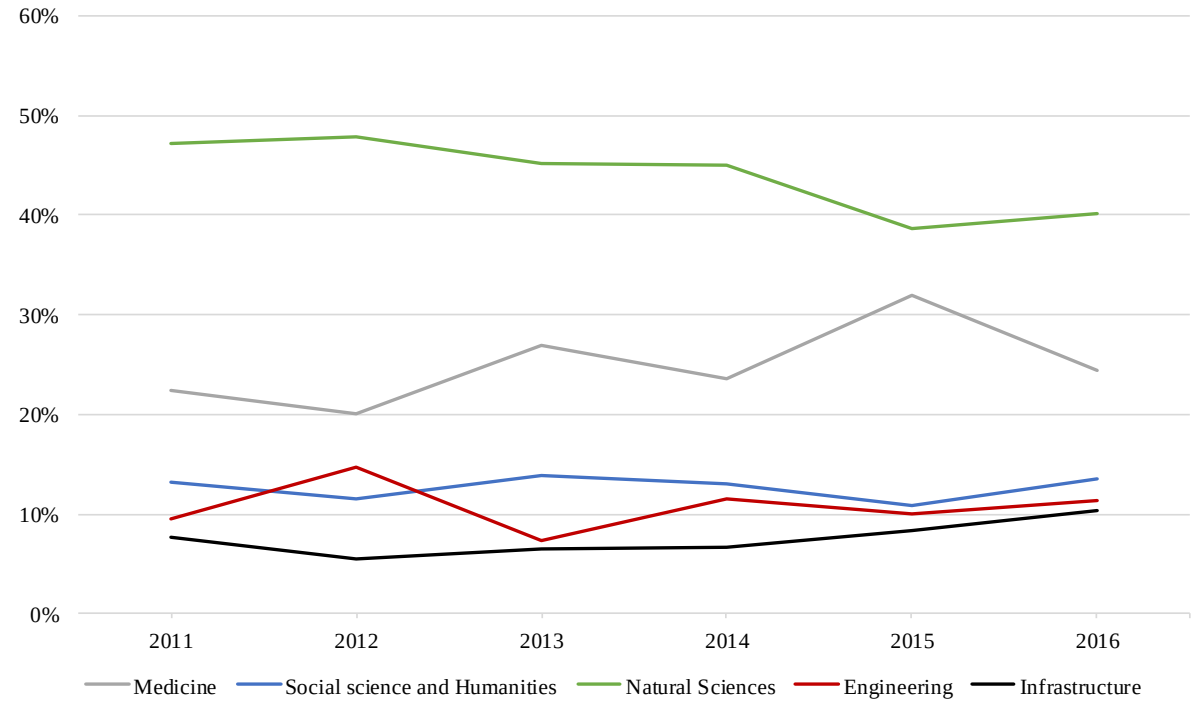
Again, due to the incomplete nature of the available data, any assessment of the changes in spending shares between schemes must be interpreted with great caution.

Table 22: UK shares of funding instruments, change in percentage points between 2016 and first available year

	share 2016	change in share	share 2016	change in share	share 2017	change in share	share 2016	change in share	share 2016	change in share	share 2016	change in share	share 2016	change in share
UK	**AHRC**	**AHRC**	**BBSRC**	**BBSRC**	**EPSRC**	**EPSRC**	**ESRC**	**ESRC**	**MRC**	**MRC**	**NERC**	**NERC**	**STFC**	**STFC**
Project funding	**80%**	**+17.1**	**56%**	**+7.8**	**100%**	**0**	**14%**	**-10.1**	**52%**	**+39.1**	**65%**	**-8.5**	**39%**	**-38.4**
Priority areas	**N/A**	**N/A**	**15%**	**+2.0**	**N/A**	**N/A**	**21%**	**-7.9**	**37%**	**-8.3**	**21%**	**+21.5**	**N/A**	**N/A**
Structural priority area	-	-	15%	+2.0	N/A	N/A	21%	-7.9	37%	+9.1	21%	+21.5	-	-
Thematic priority area	N/A	N/A	-	-	-	-	-	-	-	-17.5	N/A	N/A	N/A	N/A
Infrastructure	**-**	**-**	**14%**	**-12.5**	**-**	**-**	**15%**	**+0.3**	**-**	**-**	**N/A**	**N/A**	**20%**	**+19.7**
Funding of people	**14%**	**-23.4**	**12%**	**+2.0**	**N/A**	**N/A**	**41%**	**+12.6**	**11%**	**-11.2**	**14%**	**-13**	**9%**	**-8.5**
Education & Training	4%	+4.3	-	-	N/A	N/A	22%	-6.5	5%	-4.4	-	-	N/A	N/A
Career	9%	-27.7	12%	+2.0	N/A	N/A	19%	+19.1	7%	-6.9	14%	-13	9%	-8.5
Diversification	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prizes	-	-	-	-	-	-	N/A	N/A	-	-	-	-	-	-
Mobility	N/A	N/A	N/A	N/A	N/A	N/A	-	-	N/A	N/A	-	-	-	-
International Cooperation	**N/A**	**N/A**	**N/A**	**N/A**	**-**	**-**	**4%**	**4**	**N/A**	**N/A**	**-**	**-**	**-**	**-**
Translation	**N/A**	**N/A**	**2%**	**+0.6**	**N/A**	**N/A**	**4%**	**+1.2**	**N/A**	**N/A**	**N/A**	**N/A**	**19%**	**+18.8**
Applied Research	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R&D Collaboration with firms	-	-	2%	+0.6	N/A	N/A	4%	+1.2	N/A	N/A	-	-	N/A	N/A
Commercialisation	N/A	N/A	N/A	N/A	-	-	-	-	N/A	N/A	N/A	N/A	19%	+18.8
R&D Value Chain	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scientific Communication	**7%**	**+6.6**	**-**	**-**	**-**	**-**	**-**	**-**	**N/A**	**N/A**	**N/A**	**N/A**	**-**	**-**

Source: Annual reports of Councils, WIFO calculation. Note: Data for EPSRC are for the year 2017. First year: AHRC: 2006, BBSRC: 2009; EPSRC: 1997; ESCR: 2011; MRC: 2002; NERC: 2007; STFC: 2008.

Figure 21: Total awarded funding by discipline - UKRI, 2011-2016



Source: Annual reports of councils, WIFO calculation. Note: The discipline shares are the total awarded funding amount of the following councils: Medicine: MRC; Social Sciences and Humanities: AHRC, ESRC, Natural Sciences: BBSRC, NERC and part of EPSRC; Engineering: part of EPSRC, Infrastructure: STFC. EPSRC provided special data to be able to split its funding according to disciplines.

- Closure of funding schemes, introduction of new funding schemes:

UK Research Council continuously announce new funding opportunities following emerging scientific or societal needs.

Structural changes in allocation of funding (e.g. review procedures, overhead costs, etc.)

- Introduction of full economic costing in 2006

3.6.6 Information and data sources

Contact at fund

Council	Name	Position	Email
AHRC – Arts & Humanities RC	N/A	N/A	N/A
BBSRC – Biotechnology & Biological Sciences RC	Dr. Beverley Thomas	Associate Director, Evidence and Evaluation, Corporate Policy and Strategy Group	Beverley.Thomas@bbsrc.ukri.org
EPSRC – Engineering & Physical Sciences RC	Dr. Sue Smart	Head of Performance and Evaluation	Sue.Smart@epsrc.ukri.org
ESRC – Economic & Social RC	Dr. Alex Hulkes	Strategic Lead - Insights	Alex.Hulkes@esrc.ukri.org
MRC - Medical RC	Research Funding Policy and Delivery		ResearchFundingPolicy-andDelivery@mrc.ukri.org
NERC - Natural Environment RC	N/A	N/A	N/A
STFC – Science & Technology Facilities Council	N/A	N/A	N/A

Annual reports from websites

AHRC: 2005-2016: https://ahrc.ukri.org/newsevents/publications/annualreportandaccounts/

BBSRC: 2011-2017: https://bbsrc.ukri.org/news/accounts/

EPSRC: 2007-2017: https://epsrc.ukri.org/search-results/?keywords=annual+report&siteid=epsrc

ESRC: 2011-2017:

https://esrc.ukri.org/news-events-and-publications/publications/corporate-publications/annual-report-and-accounts/

MRC: 2000-2017: https://mrc.ukri.org/about/what-we-do/spending-accountability/annual-report/

NERC: 2008-2017: https://nerc.ukri.org/latest/publications/strategycorporate/annualreport/archive/

STFC: 2007-2017: https://www.stfc.in/annual-reports.aspx

Additional links:

https://www.ukri.org/about-us/strategic-prospectus/vision-mission-and-values/

https://www.ukri.org/about-us/governance-and-structure/executive-committee/

https://www.ukri.org/about-us/governance-and-structure/uk-research-and-innovation-board/

https://www.ukri.org/funding/peer-review/

https://www.ukri.org/files/legacy/documents/rcukpeerreviewframework-pdf/

https://www.ukri.org/files/legacy/documents/fecfaq-pdf/

3.7 National Institutes of Health (NIH, USA)

3.7.1 Organisational mission and structure

Mission focus

NIH focuses broadly on knowledge creation as well as on economic and societal impacts. The following information is taken from the NIH website:

NIH's mission is to seek fundamental knowledge about the nature and behaviour of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.

The goals of the agency are:

- to foster fundamental creative discoveries, innovative research strategies, and their applications as a basis for ultimately protecting and improving health;
- to develop, maintain, and renew scientific human and physical resources that will ensure the Nation's capability to prevent disease;
- to expand the knowledge base in medical and associated sciences in order to enhance the Nation's economic well-being and ensure a continued high return on the public investment in research; and
- to exemplify and promote the highest level of scientific integrity, public accountability, and social responsibility in the conduct of science.

Source: https://www.nih.gov/about-nih/what-we-do/mission-goals.

Sampat (2012) provides a detailed account of the NIH's mission and the relationship between a focus on basic science and on finding cures for diseases, which can lead to tensions.

Overarching decision structures

NIH operates as a governmental agency with external scientists taking on an advisory role, but without a formal say in the agency's decision-making.

The National Institutes of Health (NIH), a part of the U.S. Department of Health and Human Services, is the nation's medical research agency. It is made up of 27 different components called **Institutes and Centers, coordinated by a central Office of the NIH Director**. Each has its own specific research agenda, often focusing on particular diseases or body systems. All but three of these components receive their funding directly from Congress, and administrate their own budgets. Each NIH Institute and Center has its own director to lead the pursuit of the research mission specific to the Institute. NIH leadership plays an active role in shaping the agency's research planning, activities, and outlook.

Organisational Chart: https://oma.od.nih.gov/IC_Organization_Chart/OD%20Organizational%20Chart.pdf.

- General/strategic decision making

The **NIH Director** (since 2009: Francis S. Collins, M.D., Ph.D.), with a unique and critical perspective on the entire agency, is responsible for providing leadership to the Institutes and for constantly identifying needs and opportunities, especially for efforts that involve multiple Institutes. The NIH Director is assisted by NIH Deputy Directors including the Principal Deputy Director, who shares in the overall direction of the agency's activities.

Francis S. Collins, M.D., Ph.D. was appointed the 16th Director of the National Institutes of Health (NIH) by President Barack Obama and confirmed by the Senate. He was sworn in on August 17, 2009. On June 6, 2017, President Donald Trump announced his selection of Dr. Collins to continue to serve as the NIH Director.

The **Office of the Director (OD)** is the central office, responsible for setting policy for NIH and for planning, managing, and coordinating the programs and activities of all the NIH components. The OD comprises several offices that provide expert advice to the NIH Director and his leadership team (more information on the website).

There is also an Office for Intramural and an Office for Extramural Research. In general, NIH is quite an apolitical agency, with only the Director and the Director of the National Institute for Cancer Research politically appointed.

- Decision structures for funding

Each NIH administering **Institute and Center (IC)** has its own research agenda, driven by its focus on specific diseases, conditions, body systems, public health needs, scientific opportunities or other strategic goals. To meet this agenda, ICs set priorities for research funding, taking into consideration their five-year strategic plan, their existing research portfolio, extant and emerging public health needs, plans of other ICs, and other factors. ICs typically split their extramural research budgets by institute-initiated projects (such as those conducted by cooperative groups, networks, or centers or those conducted in response to an RFA) and investigator-initiated projects, which are largely made up of R01 grants that are submitted in response to NIH's 'parent announcement'. Some IC's spend the majority of the extramural funds on institute-initiated projects, while others spend the majority on investigator-initiated projects.

National Advisory Councils and Boards (NACs) perform the second level of peer review for research grant applications and offer advice and recommendations on policy and program development, program implementation, evaluation, and other matters of significance to the mission and goals of the respective Institutes or Centers, as well as providing oversight on research conducted by each Institute's or Center's intramural program.

Source: https://www.nih.gov/about-nih/who-we-are/organization, https://www.nih.gov/about-nih/who-we-are/nih-leadership, https://report.nih.gov/FileLink.aspx?rid=951.

Allocation of government funding to agency (budget appropriation)

All but three of NIH's ICs receive their funding directly from the Congress and administrate their own budgets. NIH prepares a yearly request for funds to the Congress. In addition, members of Congress can push for additional funding. NIH was also a beneficiary of the 2009 ARRA, the fiscal stimulus programme in the wake of the financial crisis, an unusual countercyclical increase of university/basic research funding (*Stephan, 2012*). Congress votes more easily for medicine than physical or engineering sciences (*Stephan, 2012*). *Sampat (2012)* provides a detailed account of the funding allocation process, including the relationship between the agency, Congress, and interest groups, as well as the way health considerations enter the budget appropriation process next to science considerations (referring to the focus of NIH on both scientific understanding of the working of the human diseases and treating specific diseases).

Budget increases usually in lockstep across the 27 institutes (*Sampat, 2012*), with some exceptions, e.g. the NIAID National Institute of Allergic and Infectious Diseases got disproportionate increases as a result of AIDS.

Organisation of funding activities

NIH funding activities can be characterised as working through the decentralized 27 institutes (with coordination by the NIH Office); funding activities are discipline-specific, of course, and rely on common instruments such as research project grants, centres and contracts (see next section).

NIH uses activity codes to differentiate the wide variety of research-related programs it supports. NIH Institutes and Centers (ICs) may vary in the way they use activity codes; not all ICs accept applications for all types of grant programs or they apply specialized eligibility criteria. Besides, not all of the activity codes may be in use by NIH every year. At NIH it is possible to submit applications both unsolicited (through "Parent Announcements" – i.e. researchers define the research questions bottom-up) and solicited (through specific funding opportunities (FOA) of the activity codes – i.e. researchers respond to research questions asked by NIH).

Source: https://grants.nih.gov/grants/funding/funding_program.htm.

There is however also a Common Fund: The Office of the Director consists of several offices, one of which is the Division of Program Coordination, Planning, and Strategic Initiatives (DPCPSI). Its Office of Strategic Coordination manages the Common Fund.

Source: NIH (2012): Report of the Director National Institutes of Health, Fiscal Year 2012 & 2013, https://report.nih.gov/pdf/NIH_Biennial_Report_2012.pdf.

NIH provides several types of grant support. The following groupings represent the main types of grant funding:

- **Research Grants (R series)**
- **Small Business Grants (R):** These small business programs support research and development by small businesses of innovative technologies that have the potential to succeed commercially or provide significant societal benefits.
- **Career Development Awards (K series) & Research Training and Fellowships (T&F series)** provide institutional research training opportunities (including international) to trainees at the undergraduate, graduate, and postdoctoral levels.
- **Program Project/Center Grants (P series)** support large, multi-project efforts that generally include a diverse array of research activities. NIH Institutes and Centers issue funding opportunity announcements to indicate their interest in funding this type of program.
- **Resource Grants (various series)**
- **Trans-NIH Programs** support broad-reaching programs that are trans-NIH in nature (e.g. programs of the NIH Common Fund).

Source: Type of Grant Programs, https://grants.nih.gov/grants/funding/funding_program.htm; Small Business Research, https://www.nimh.nih.gov/funding/sbir/index.shtml.

3.7.2 Overview of funding schemes

We don't show all the activity codes for most of the funding schemes, just those with a budget share of more than 0.3% (this results in 55 activity codes out of 242 in total (last update of the number of activity codes, which keep changing: August 2018); as an exception to this rule we also included early-career and high risk single-project funding.

Research topic origin: Proposal topic is investigator-initiated ("bottom-up") or proposed by science fund ("top-down").

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Research Career	K00	Career	yes	N/A	Person	Post-doctoral Transition Award To support the second phase of a Pre-Doctoral to Post-Doctoral Transition award program that provides 3-4 years of career support.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=K00&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	K01	Career	yes	N/A	Person	Mentored Research Scientist Career Development Award The purpose of this program is to provide support and protected time for an intensive, supervised career development experience in the biomedical, behavioural, or clinical sciences leading to research independence. Some NIH Institutes use the K01 to enhance workforce diversity, or for individuals who propose to train in a new field, or for individuals who have had a hiatus in their research career.	https://researchtraining.nih.gov/programs/career-development/K01
	K02	Career	yes	N/A	Person	Independent Research Scientist Development Award The purpose of this program is to foster the development of newly independent, outstanding scientists who can demonstrate the need for a period of intensive research, to enable them to expand their potential to make significant contributions to their field of research.	https://researchtraining.nih.gov/programs/career-development/K02
	K05	Career	yes	N/A	Person	Senior Research Scientist Award The purpose of this program is to provide protected time to established researchers to devote effort to basic or clinical research and to act as research mentors to early-stage investigators. Candidates for this award should have independent, peer-reviewed, research support at the time of award and possess a demonstrated record of mentoring.	https://researchtraining.nih.gov/programs/career-development/K05
	K07	Career	yes	N/A	Person	Academic Career Development Award The purpose of this program is to provide support for academic researchers and to enhance the educational or research capacity at the sponsoring institution. The K07 supports both development awards for more junior	https://researchtraining.nih.gov/programs/career-development/K07

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
						candidates, and leadership awards for more senior individuals with acknowledged scientific expertise and leadership skills.	
	K08	Career	yes	N/A	Person	Mentored Clinical Scientist Research Career Development Award The purpose of this program is to prepare clinically trained individuals for careers that have a significant impact on the health-related research needs of the Nation. This program provides support and protected time for an intensive, supervised research career development experience in the fields of biomedical, behavioural, or clinical research, including translational research.	https://researchtraining.nih.gov/programs/career-development/K08
	K12	Career	yes	N/A	Person	Clinical Scientist Institutional Career Development Program Award The purpose of this program is to support institutional career development awards designed to prepare newly-trained clinicians who have made a commitment to independent research careers, and to facilitate their transition to more advanced support mechanisms, e.g., K08 and K23.	https://researchtraining.nih.gov/programs/career-development/K12
	K18	Career	yes	N/A	Person	Research Career Enhancement Award for Established Investigators This program provides either full-time or part-time support for experienced scientists to augment or redirect their research programs through the acquisition of new research skills or to make changes in their research careers by acquiring new research skills or knowledge.	https://researchtraining.nih.gov/programs/career-development/K18
	K22	Career	yes	N/A	Person	Career Transition Award The goal of this program is to facilitate the transition of investigators to independent, productive research careers. One or two phase award; an initial period of mentored research, followed by a period of independent research at an extramural institution.	https://researchtraining.nih.gov/programs/career-development/K22
	K24	Career	yes	N/A	Person	Midcareer Investigator Award in Patient-Oriented Research The purpose of this program is to provide support to mid-career health-professional doctorates or equivalent who are typically at the Associate Professor level for protected time to devote to patient-oriented research and to act as research mentors primarily for clinical residents, clinical fellows and/or junior clinical faculty.	https://researchtraining.nih.gov/programs/career-development/K24
	K25	Career	yes	N/A	Person	Mentored Quantitative Research Career Development Award The purpose of this award is to attract to NIH-relevant research those investigators whose quantitative science and engineering research has thus far not been focused primarily on questions of health and disease. The K25	https://researchtraining.nih.gov/programs/career-development/K25

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
						supports productive professionals with quantitative (e.g., statistics, economics, computer science, physics, chemistry) and engineering backgrounds to integrate their expertise with NIH-relevant research.	
	K26	Career	yes	N/A	Person	Midcareer Investigator Award in Biomedical and Behavioral Research The purpose of this award is to support biomedical and behavioural scientists to allow them protected time to devote to their research and mentoring. The goal of this program is to support established, outstanding investigators by providing protected time for research and mentoring.	https://researchtraining.nih.gov/programs/career-development/K26
	K43	Career	yes	N/A	Person	Emerging Global Leader Award The purpose of the Fogarty Emerging Global Leader Award is to provide research support and protected time to a research scientist from a low- or middle-income country (LMIC) with a junior faculty position at an LMIC academic or research institution leading to an independently funded research career.	https://researchtraining.nih.gov/programs/career-development/K43
	K76	Career	yes	N/A	Person	Emerging Leaders Career Development Award The purpose of this program is to develop of a cadre of talented scientists prepared and willing to take an active leadership role in transformative change that will lead to improved health care outcomes.	https://researchtraining.nih.gov/programs/career-development/K76
	K99	Career	yes	N/A	Person	Pathway to Independence Award The purpose of this program is to increase and maintain a strong cohort of new and talented, NIH-supported, independent investigators. This program is designed to facilitate a timely transition of outstanding postdoctoral researchers or clinician-scientists from mentored research positions to independent, tenure-track or equivalent faculty positions, and to provide independent NIH research support during the transition that will help these individuals launch competitive, independent research careers.	https://researchtraining.nih.gov/programs/career-development/K99-R00
	KL2	Career	yes	N/A	Person	Mentored Career Development Award To support newly trained clinicians appointed by an institution for activities related to the development of a successful clinical and translational research career.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=KL2&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
NRSA Fellowships	F30	Career	yes	N/A	Person	Ruth L. Kirschstein Individual Predoctoral NRSA for MD/PhD and other Dual Degree Fellowships	https://researchtraining.nih.gov/programs/fellowships/F30

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
						The purpose of this Kirschstein-NRSA program is to enhance the integrated research and clinical training of promising predoctoral students, who are matriculated in a combined MD/PhD or other dual-doctoral degree training program (e.g. DDS/PhD, AuD/PhD, DVM/PhD), and who intend careers as physician-scientists or other clinician-scientists.	
	F31	Career	yes	N/A	Person	Ruth L. Kirschstein Predoctoral Individual National Research Service Award The purpose of this Kirschstein-NRSA program is to enable promising predoctoral students with potential to develop into a productive, independent research scientists, to obtain mentored research training while conducting dissertation research. The F31 is also used to enhance workforce diversity though a separate program.	https://researchtraining.nih.gov/programs/fellowships/F31
	F32	Career	yes	N/A	Person	Ruth L. Kirschstein Postdoctoral Individual National Research Service Award The purpose of the Kirschstein-NRSA postdoctoral fellowship is to enhance the research training of promising postdoctoral candidates who have the potential to become productive, independent investigators in scientific health-related research fields relevant to the missions of the participating NIH Institutes and Centers.	https://researchtraining.nih.gov/programs/fellowships/F32
SBIR/STTR	R41	R&D Collaboration with firms	yes	-	Project	Small Business Technology Transfer (STTR) Grants - Phase I To support cooperative R&D projects between small business concerns and research institutions, limited in time and amount, to establish the technical merit and feasibility of ideas that have potential for commercialization. Awards are made to small business concerns only.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=R41&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	R42 & UT2	R&D Collaboration with firms	yes	-	Project	Small Business Technology Transfer (STTR) Grants - Phase II (R42) To support in-depth development of cooperative R&D projects between small business concerns and research institutions, limited in time and amount, whose feasibility has been established in Phase I and that have potential for commercialization. Awards are made to small business concerns only. Small Business Technology Transfer (STTR) – Cooperative Agreements - Phase II (UT2) To support in-depth development of cooperative research and development projects between small business concerns and research institutions, limited	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=R42&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev= https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=UT2&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
						in time and amount, whose feasibility has been established in Phase I and that have potential for commercialization.	
	R43 & U43	R&D Collaboration with firms	yes	-	Project	Small Business Innovation Research Grants (SBIR) - Phase I (R43) & Small Business Innovation Research (SBIR) Cooperative Agreements - Phase I (U43) To support projects, limited in time and amount, to establish the technical merit and feasibility of R&D ideas which may ultimately lead to a commercial product(s) or service(s).	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=R43&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev= https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=U43&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	R44 & U44	R&D Collaboration with firms	yes	-	Project	Small Business Innovation Research Grants (SBIR) - Phase II (R44) To support in - depth development of R&D ideas whose feasibility has been established in Phase I and which are likely to result in commercial products or services. SBIR Phase II are considered "Fast-Track" and do not require National Council Review. Small Business Innovation Research (SBIR) Cooperative Agreements - Phase II (U44) To support in-depth development of R&D ideas whose feasibility has been established in Phase I and that are likely to result in commercial products or services.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=R44&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev= https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=U44&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	SB1	Commercialisation	yes	-	Project	Commercialization Readiness Program To support follow-on awards to small businesses for technology development, testing, evaluation, and commercialization assistance for SBIR or STTR Phase II technologies or for awards to small businesses to support the progress of research, research and development, and commercialization conducted under the SBIR or STTR programs to Phase III.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=SB1&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
NRSA institutional	T32	Education & Training	yes	-	Institution	Ruth L. Kirschstein Institutional National Research Service Award The purpose of this Kirschstein-NRSA training program is to enable institutions to recruit individuals selected by them for predoctoral and postdoctoral research training in specified shortage areas. The goal of this	https://researchtraining.nih.gov/programs/training-grants/T32

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
						program is to prepare qualified predoctoral and/or postdoctoral trainees for careers that have a significant impact on the health-related research needs of the Nation.	
	T34	Education & Training	yes	-	Institution	Ruth L. Kirschstein Undergraduate NRSA Institutional Research Training Grants The purpose of the Kirschstein-NRSA MARC U-STAR program is to support undergraduate academic and research training to help ensure that a diverse and highly trained workforce is available to assume leadership roles related to the Nation's biomedical and behavioural research agenda.	https://researchtraining.nih.gov/programs/training-grants/T34
	T35	Education & Training	yes	-	Institution	Ruth L. Kirschstein NRSA Short-Term Institutional Research Training Grant The goal of this Kirschstein-NRSA training program is to support short-term research training for students in health professional schools during the summer, or for predoctoral and/or postdoctoral training in focused, often emerging scientific areas.	https://researchtraining.nih.gov/programs/training-grants/T35
	T36	Education & Training	yes	-	Institution	N/A	N/A
	T90	Interdisciplinary research	yes	-	Institution	Ruth L. Kirschstein Interdisciplinary Research Training Award The goal of this Kirschstein-NRSA program is to support comprehensive interdisciplinary research training programs at the undergraduate, predoctoral and/or postdoctoral levels, by capitalizing on the infrastructure of existing multidisciplinary and interdisciplinary research programs. The R90 component can support trainees who do not meet the qualifications for support under the NRSA program.	https://researchtraining.nih.gov/programs/training-grants/T90-R90
	TL1	Education& Training	yes	-	Institution	Linked Training Award To support research training experiences for pre-doctoral trainees who are interested in pursuing research careers in multi-disciplinary clinical and translational science. The training award is administratively linked to another project or projects. A TL1 award may only be disaggregated from a U54 application and organizations may not apply for a TL1, Linked Training Award. The TL1 is used in lieu of the T32 for those programs that offer linked awards.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=TL1&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	TL4	Diversification	yes	-	Institution	Undergraduate NRSA Institutional Research Training Grants	https://grants.nih.gov/grants/funding/ac_search_results.htm?te

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
						To enhance the undergraduate research training of individuals from groups underrepresented in biomedical, behavioural, clinical and social sciences through Institutional National Research Service Award Training Grants, in preparation for research doctorate degree programs. This is the linked equivalent of the T34.	xt_curr=TL4&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
Research Projects	R01	Single Project funding (SPF)	yes	Bottom-Up/ Top-Down	Project	Research Project Grant Program The Research Project Grant (R01) is the original and historically oldest grant mechanism used by NIH. The Research Project (R01) grant is an award made to support a discrete, specified, circumscribed project to be performed by the named investigator(s) in an area representing the investigator's specific interest and competencies, based on the mission of the NIH.	https://grants.nih.gov/grants/funding/r01.htm
	R21	Single Project funding (SPF)	yes	Bottom-Up	Project	Exploratory/Developmental Research Grant Award The R21 grant mechanism is intended to encourage exploratory/developmental research by providing support for the early and conceptual stages of project development.	https://grants.nih.gov/grants/funding/r21.htm
	RF1	Single Project funding (SPF)	yes	Bottom-Up/ Top-Down	Project	**Multi-Year Funded Research Project Grant** To support a discrete, specific, circumscribed project to be performed by the named investigator(s) in an area representing specific interest and competencies based on the mission of the agency, using standard peer review criteria. This is the multi-year funded equivalent of the R01 but can be used also for multi-year funding of other research project grants such as R03, R21 as appropriate.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=RF1&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	R35	SPF high-risk	yes	-	Person	Outstanding Investigator Award To provide long term support to an experienced investigator with an outstanding record of research productivity. This support is intended to encourage investigators to embark on long-term projects of unusual potential.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=R35&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	U01	Networks and Multi-Project funding	yes	-	Project	**Research Project--Cooperative Agreements** Supports discrete, specified, circumscribed projects to be performed by investigator(s) in an area representing their specific interests and competencies. It is used when substantial programmatic involvement is anticipated between the awarding Institute and Center.	https://grants.nih.gov/grants/funding/funding_program.htm#u01

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
	P01	Networks and Multi-Project funding	yes	-	Project	Research Program Project Grant For the support of a broadly based, multidisciplinary, often long-term research program which has a specific major objective or a basic theme.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=P01&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	UM1	Networks and Multi-Project funding	yes	-	Project	Research Project with Complex Structure Cooperative Agreement To support cooperative agreements involving large-scale research activities with complicated structures that cannot be appropriately categorized into an available single component activity code, e.g. clinical networks, research programs or consortium.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=UM1&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	U19	Networks and Multi-Project funding	yes	-	Project	Research Program--Cooperative Agreements To support a research program of multiple projects directed toward a specific major objective, basic theme or program goal, requiring a broadly based, multidisciplinary and often long-term approach.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=U19&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
High-Risk, High-Reward Research program	DP1	SPF high-risk	yes	-	Person	The NIH Director's Pioneer Award (DP1 mechanism), established in 2004, supports highly innovative researchers at any career stage who propose bold research projects with unusually broad scientific impact. To be considered "pioneering," the proposed research must reflect ideas that are substantially different from those being pursued in the investigator's research program or elsewhere.	https://commonfund.nih.gov/pioneer
	DP2	SPF Early career	yes	-	Person	The NIH Director's New Innovator Award (DP2 mechanism), established in 2007, supports highly innovative research from promising Early Stage Investigators (defined as those within 10 years of completing their terminal research degree or postgraduate clinical training and who have not yet received substantial NIH support).	https://commonfund.nih.gov/newinnovator/
	DP5	SPF high-risk	yes	-	Person	The NIH Director's Early Independence Award (DP5 mechanism), established in 2010, accelerates the entry of exceptional junior investigators (within 15 months after or 12 months before receiving their terminal research degree or completing postgraduate clinical training) into positions of independent research by omitting the traditional postdoctoral training period. The review places a strong emphasis on the qualities of the investigator and the environment provided by the host institution.	https://commonfund.nih.gov/earlyindependence/

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Research Centers	P30	Infrastructure	yes	-	Infrastructure	Center Core Grants To support shared resources and facilities for categorical research by a number of investigators from different disciplines who provide a multidisciplinary approach to a joint research effort or from the same discipline who focus on a common research problem. The core grant is integrated with the center's component projects or program projects, though funded independently from them.	https://grants.nih.gov/grants/funding/funding_program.htm#PSeries
	U54 & P50	R&D Value Chain	yes	-	Project	Specialized Center--Cooperative Agreements (U54) & Specialized Center (P50) To support any part of the full range of research and development from very basic to clinical; may involve ancillary supportive activities such as protracted patient care necessary to the primary research or R&D effort. The spectrum of activities comprises a multidisciplinary attack on a specific disease entity or biomedical problem area.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=U54&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev= https://grants.nih.gov/grants/funding/funding_program.htm#PSeries
	UL1	Applied Research	yes	-	Project	Linked Specialized Center Cooperative Agreement To support clinical and translational research. The UL1 administratively linked to another project or projects. AUL1 award may only be disaggregated from a U54 application and organizations may not apply for a UL1, Linked Specialized Center Cooperative Agreement. The UL 1 activity code is used in lieu of the U54 for those programs that offer linked awards.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=UL1&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	P20	Applied Research	yes	-	Project	Exploratory Grants To support planning for new programs, expansion or modification of existing resources, and feasibility studies to explore various approaches to the development of interdisciplinary programs that offer potential solutions to problems of special significance to the mission of the NIH. These exploratory studies may lead to specialized or comprehensive centers.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=P20&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
Other Research	U24 & R24	Infrastructure	yes	-	Infrastructure	Resource-Related Research Projects--Cooperative Agreements (U24) & Resource-Related Research Projects (R24) To support research projects contributing to improvement of the capability of resources to serve biomedical research.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=U24&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=

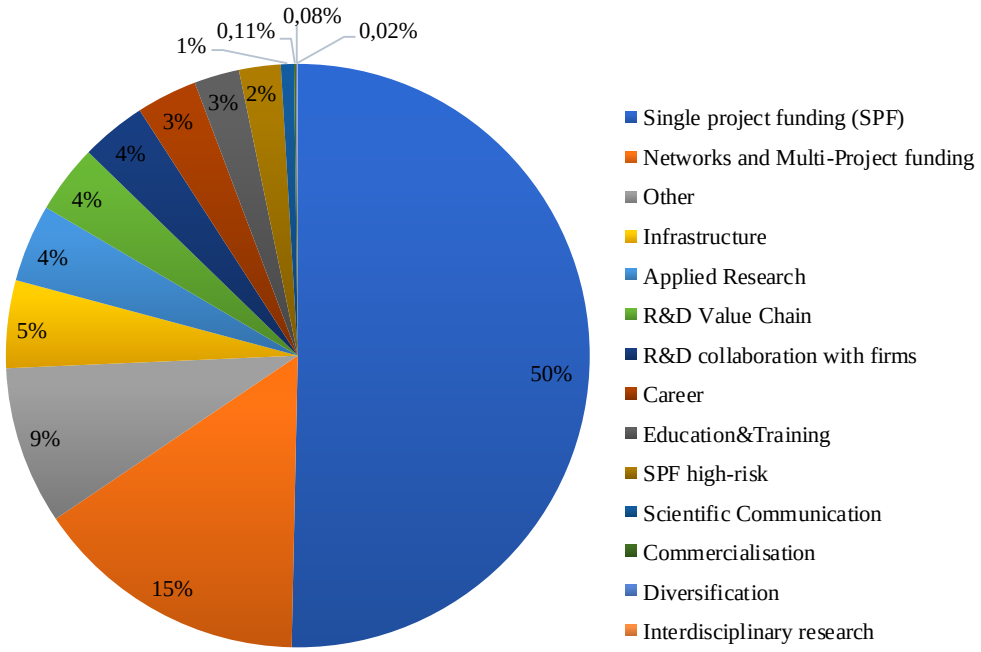
Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
							https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=R24&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	U10	Applied Research	yes	-	Project	Cooperative Clinical Research--Cooperative Agreements To support clinical evaluation of various methods of therapy and/or prevention in specific disease areas. These represent cooperative programs between sponsoring institutions and participating principal investigators, and are usually conducted under established protocols.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=U10&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	UG1	Applied Research	yes	-	Project	Clinical Research Cooperative Agreements - Single Project To support single project applications conducting clinical evaluation of various methods of therapy and/or prevention (in specific disease areas). NOTE: The UG1 is the single-component companion to the U10 which is used for multi-project applications only.	https://grants.nih.gov/grants/funding/ac_search_results.htm?text_curr=UG1&Search.x=0&Search.y=0&sort=ac&Search_Type=Activity&text_prev=
	R25	Scientific Communication	yes	-	-	Education Projects Used in a wide variety of ways to promote an appreciation for and interest in biomedical research, provide additional training in specific areas, and/or to develop ways to disseminate scientific discovery into public health and community applications.	https://grants.nih.gov/grants/funding/funding_program.htm#Resource

Source: Content of funding schemes: https://grants.nih.gov/grants/funding/ac_search_results.htm, https://grants.nih.gov/grants/funding/funding_program.htm#Resource, application documents of funding schemes. Bottom-Up/Top-Down is assessment by WIFO based on the online description of the funding schemes and the application documents.

3.7.3 Characteristics of funding schemes

As in principle all of NIH funding is directed at medicine, we don't show the share by discipline for the NIH. However, there may be research projects not anchored in medicine/biology, e.g. in nanotechnology, but which have a potential impact on medicine (or which are being proposed by researchers as potentially impacting on medicine, *Stephan, 2012*). The funding portfolio shows the dominant role of single project finding, in spite of the large variety of funding schemes or instruments available. Together with networks and multi-project funding, as well as SPF high risk and interdisciplinary research, project-oriented funding achieves close to 70% of total funding. The category "other" corresponds to very small funding instruments which we have not assessed. Translational schemes, such as R&D value chain, commercialisation and R&D collaboration with firms, also amount together to a sizeable portion of NIH funds. Note that there is no dedicated thematic priority area, but this is a result of the presentation of the data – the activity codes are instruments often used by the Institutes for a specific thematic focus.

Figure 22: NIH total awarded funding according to study author classification, 2017



Source: NIH, WIFO calculation. Note: The category „Other" includes those activity codes that were not taken into account due to their small percentage share (< 0,1%).

The table below summarises the grant design characteristics and success rates. The main single project funding scheme R01 shows rather low success rates below 20%, similar to interdisciplinary funding at 22%, but other schemes such as SPF early career or high risk are even more difficult to obtain with success rates at 10-12%. Career-oriented schemes show on average higher success rates, as do the network- and multi-project schemes.

Table 23: Selected characteristics of the funding schemes, 2017

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
Total		**100%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Project funding		**68%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Single project funding (SPF)		50%	N/A	0.39	N/A	average: 3.6 years	N/A
	R01	45%	not limited	0.41	3-5 years	N/A	19%

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
	R21	4%	max. 0.24 Mio. EUR. not more than 0.18 Mio. EUR/year	0.19	2 years	N/A	14%
	RF1	2%	N/A	2.80	N/A	N/A	100%
SPF Early career		1%	1.34 Mio. EUR/year	1.99	max. 5 years	N/A	12%
	DP2	1%	1.34 Mio. EUR/year	1.99	max. 5 years	N/A	12%
SPF high-risk		2%	N/A	0.55	N/A	N/A	N/A
	R35	1,5%	N/A	0.52	N/A	N/A	100%
	DP1	0.3%	0.62 Mio. EUR/year	0.78	max. 5 years	N/A	10%
Networks and Multi-Project funding		15%	N/A	1.35	N/A	N/A	N/A
	U01	7%	not limited	0.90	N/A	N/A	23%
	P01	3%	not limited	1.67	N/A	N/A	28%
	UM1	3%	N/A	3.96	N/A	N/A	50%
	U19	2%	N/A	2.40	N/A	N/A	38%
Interdisciplinary research		0.02%	N/A	0.27	N/A	N/A	N/A
	T90	0.02%	N/A	0.27	N/A	N/A	22%
Priority areas		-	-	-	-	-	-
Structural priority area		-	-	-	-	-	-
Thematic priority area		-	-	-	-	-	-
Infrastructure		**5%**	**N/A**	**1.35**	**N/A**	**N/A**	**N/A**
	P30	3%	N/A	1.53	N/A	N/A	51%
	U24	2%	N/A	1.58	N/A	N/A	33%
	R24	1%	N/A	0.65	N/A	N/A	21%
Funding of people		**6%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Education & Training		3%	N/A	0.3	N/A	N/A	N/A
	T32	2%	not limited	0.31	5 years	N/A	51%
	T34	0.07%	N/A	0.30	N/A	N/A	34%
	T35	0.03%	not limited	0.08	5 years	N/A	70%
	T36	0.01%	N/A	0.51	N/A	N/A	N/A
	TL1	0.1%	N/A	0.44	N/A	N/A	100%
Career		3%	0.16 Mio. EUR	0.13	N/A	N/A	N/A
	K00	0.001%	N/A	0.07	3-5 years	N/A	N/A
	K01	0.5%	N/A	0.13	3-5 years	N/A	31%
	K02	0.02%	N/A	0.13	3-5 years	N/A	56%
	K05	0.01%	N/A	0.12	3-5 years	N/A	N/A
	K07	0.05%	N/A	0.14	3-5 years	N/A	14%

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
	K08	0.5%	N/A	0.15	3-5 years	N/A	44%
	K12	0.3%	N/A	0.49	3-5 years	N/A	46%
	K18	0.001%	N/A	0.15	3-5 years	N/A	N/A
	K22	0.1%	N/A	0.15	3-5 years	N/A	19%
	K23	0.7%	N/A	N/A	3-5 years	N/A	34%
	K24	0.1%	N/A	0.14	3-5 years	N/A	40%
	K25	0.03%	N/A	0.13	3-5 years	N/A	40%
	K26	0.001%	N/A	0.10	3-5 years	N/A	N/A
	K43	0.01%	N/A	0.08	3-5 years	N/A	N/A
	K76	0.01%	N/A	0.18	3-5 years	N/A	N/A
	K99	0.2%	N/A	0.10	3-5 years	N/A	23%
	KL2	0.2%	N/A	0.71	3-5 years	N/A	100%
	F30	0.1%	N/A	0.11	max. 6 years	N/A	39%
	F31	0.2%	N/A	0.08	max. 5 years	N/A	26%
	F32	0.3%	N/A	0.12	max. 3 years	N/A	28%
Diversification		0.1%	N/A	1.78	N/A	N/A	N/A
	TL4	0.1%	N/A	1.78	N/A	N/A	N/A
Prizes		-	-	-	-	-	-
Mobility		-	-	-	-	-	-
International Cooperation		-	-	-	-	-	-
Translation		**12%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Applied Research		4%	N/A	1.8	N/A	N/A	N/A
	UL1	2%	N/A	5.38	N/A	N/A	100%
	P20	1%	N/A	1.60	N/A	N/A	23%
	U10	1%	N/A	1.37	N/A	N/A	100%
	UG1	1%	N/A	0.86	N/A	N/A	52%
R&D Collaboration with firms		4%	N/A	0.45	N/A	N/A	N/A
	R41	0.2%	0.13-0.2 Mio. EUR	0.22	max. 1 year	N/A	16%
	R42	0.3%	0.89-1.33 Mio. EUR	0.60	max. 2 years	N/A	28%
	R43	0.6%	0.13-0.2 Mio. EUR	0.21	max. 6 months	N/A	16%
	R44	2.5%	0.89-1.33 Mio. EUR	0.63	max. 2 years	N/A	29%
	U43	0.002%	see R43	0.27	N/A	N/A	N/A
	U44	0.03%	see R44	0.73	N/A	N/A	14%
Commercialisation		0.1%	N/A	0.63	N/A	N/A	N/A
	SB1	0.1%	0.27-2.66 Mio. EUR	0.63	2-3 years	N/A	29%
R&D Value Chain		4%	N/A	1.81	N/A	N/A	N/A
	U54	2%	N/A	1.74	N/A	N/A	25%
	P50	2%	N/A	1.90	N/A	N/A	27%

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
Scientific Communication		**1%**	**N/A**	**0.23**	**N/A**	**N/A**	**33%**
	R25	1%	0.22 Mio. EUR/year	0.23	N/A	N/A	33%

Source: NIH funding facts, https://report.nih.gov/fundingfacts/fundingfacts.aspx. Note: Lot size is the size of the total grant (the total amount of money granted for the researcher's proposal) which will usually be consumed over a period of several years (funding duration). Lot size according to application documents is the maximum amount of money researchers can ask for (or the minimum-maximum range); Lot size statistical is the actual average amount of money paid out for granted projects. Lot sizes have been converted from USD to EUR. Exchange rate from January 1, 2017: 0.89. Minor deviations due to rounding. Success rates are the share of granted applications relative to the total number of full applications. A "-"-sign indicates that data/the scheme do not exist at all ; "N/A" indicates that an assessment category is not applicable to the individual funding scheme, or that data are not available. "Not limited" = The budget is not limited unless specified in the FOAs. The funds may only be used for expenditure directly related to and necessary for research training. *calculated by WIFO. The project duration/ duration of funding and lot size can vary between the institutions depending on the Funding Opportunity Announcement (see e.g. FOA page: https://grants.nih.gov/funding/searchguide/index.html).

There is also data on the percentage for targeted research. Targeted Research is research funded as a result of an Institute's set aside of dollars for a specific scientific area. Institutes solicit applications ("top-down") using research initiatives (Request for Applications (RFAs) for grants, Request for Proposal (RFPs) for contracts). In the period 1999-2015, 7% to 16% of R01-equivalents funding[6], i.e. schemes related to single project funding, was "targeted".

R01 grants can be renewed, which is done regularly (in 2017, 27% of R01 new grants were renewals), and usually achieve higher success rates than first-time applications (between 24% and 50% according to the institutes, whereas the success rate of "new" applications was between 11% and 26% according to the institutes.

Source: Table #206, https://report.nih.gov/DisplayRePORT.aspx?rid=565.

3.7.4 Refundable costs and review procedures of single project funding (R01)

The following costs will be refunded:

- Wage(s) of the applicant(s)/principal investigator,
- Wages of scientific/technical staff,
- Material expenses (i.e. Costs for equipment and materials of permanent value, direct costs for the use of infrastructures (including costs for maintenance and care), consumables, field expenses, computing time and data (cloud computing), costs for making research data accessible (open research data),
- Mobility (Travel (incl. accommodation and catering costs), conferences and workshops,
- Third-party expenses (Costs of project partners (not wages), consulting, consortia, outsourcing through subcontracting),
- Costs of scientific (open access) publications,
- Administrative/indirect costs (e.g. depreciation; maintenance; library costs; interest on debt; general administrative expenses; departmental administrative expenses; sponsored projects administration; and student administration expenses, from *Stephan, 2012*)

- Indirect cost rate (overheads): in principle, 100% of indirect costs are reimbursed - Research institutions in the US can have their full indirect costs reimbursed for all federal research grants: in 2010. the indirect cost rate (the indirect costs relative to the direct costs) amounted to 29.8-69% of the direct cost of research (*Sale - Sale*, 2010). Universities calculate the indirect costs they ask for themselves, subject to an audit by the agency and to guidelines by the OMB (Office of Management and Budget), it is not determined by the agencies. This is a time-consuming process which is updated every three years (*Stephan, 2012*).

[6] The data refer to the "R01-equivalent" awards pool, which NIH identifies as a grouping of the following activity codes: DP2, R01, R23, R29, R37 und RF1 (see section 3.6.2. for the explanation of these activity codes, mostly types of project funding). NIH usually looks at R01s in conjunction with other awards providing similar support analogous to an R01. Of the R01-equivalent pool however, R01s make up the overwhelming bulk of these grants (see also https://nexus.od.nih.gov/all/2015/04/10/looking-at-recent-data-on-r21-and-r01-equivalent-grants/).

Source: https://www.niaid.nih.gov/grants-contracts/understanding-indirect-costs-0, https://grants.nih.gov/grants/policy/nihgps/html5/section_7/7_cost_consideration.htm?tocpath=7%20Cost%20Consideration%7C_____0.

Table 24: Overview of review process

The following information is taken from the NIH website. It shows the general review process, standard criteria and considerations. If individual funding schemes may have additional criteria and consideration it is mentioned in the individual Funding Opportunity Announcements (FOAs).

Internal/External reviewers:	external/internal reviewers by Scientific Review Group (SRG) and National Advisory Council/Board (NAC) of the potential awarding Institute/Center (IC)
Number of reviewers (per proposal):	N/A
International/National reviewers:	national
Organisation of Review:	**panel review** by SRG and NAC of the potential awarding IC **1st level of the review process:** A SRG (or study section) is led by SRO (Scientific Review Officer, an NIH extramural staff scientist) who selects the individual peer reviewers (study sections are composed of pre-selected members serving multiyear terms, to which the SRO may add additional reviewers). Individual reviewers prepare written grant reviews and discuss the scientific and technical merit of the applications under review in the SRG meeting. Federal officials may participate if they have pertinent responsibilities, NIH staff by decision of the SRO. Note SRGs: no more than ¼ of the members of any SRG may be federal employees. **2nd level of the review process:** Advisory Council/Board of the potential awarding Institute/Center as reviewer (scientists from the extramural research community and public representatives – NIH maintains over 150 charted advisory committees, authorized by the Public Health Service Act). Members are chosen by the respective IC and are approved by the Department of Health and Human Services. For certain committees, members are appointed by the President of the United States). Council members have access to applications and summary statements pending funding for that IC in that council round. NIH program staff also provide a grant funding plan to the AC/B, and applications by investigators who already receive more than USD 1 million in funding are subject to a Special Council Review. The Advisory Council/Board also considers the Institute/Center's goals and needs and advises the Institute/Center director concerning funding decisions. The Institute/Center director makes final funding decisions based on staff and Advisory Council/Board advice.
Assessment criteria (incl. weights or relative importance. if available):	**Scored Review Criteria** (scored individually and considered in overall impact score) (see details below): • Significance Does the project address an important problem or a critical barrier to progress in the field? Is there a strong scientific premise for the project? If the aims of the project are achieved, how will scientific knowledge, technical capability, and/or clinical practice be improved? How will successful completion of the aims change the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field?

	• Investigator(s) Are the PD/PIs, collaborators, and other researchers well suited to the project? If Early Stage Investigators or those in the early stages of independent careers, do they have appropriate experience and training? If established, have they demonstrated an ongoing record of accomplishments that have advanced their field(s)? If the project is collaborative or multi-PD/PI, do the investigators have complementary and integrated expertise; are their leadership approach, governance and organizational structure appropriate for the project? • Innovation Does the application challenge and seek to shift current research or clinical practice paradigms by utilizing novel theoretical concepts, approaches or methodologies, instrumentation, or interventions? Are the concepts, approaches or methodologies, instrumentation, or interventions novel to one field of research or novel in a broad sense? Is a refinement, improvement, or new application of theoretical concepts, approaches or methodologies, instrumentation, or interventions proposed? • Approach Are the overall strategy, methodology, and analyses well-reasoned and appropriate to accomplish the specific aims of the project? Have the investigators presented strategies to ensure a robust and unbiased approach, as appropriate for the work proposed? Are potential problems, alternative strategies, and benchmarks for success presented? If the project is in the early stages of development, will the strategy establish feasibility, and will particularly risky aspects be managed? Have the investigators presented adequate plans to address relevant biological variables, such as sex, for studies in vertebrate animals or human subjects? • Environment Will the scientific environment in which the work will be done contribute to the probability of success? Are the institutional support, equipment and other physical resources available to the investigators adequate for the project proposed? Will the project benefit from unique features of the scientific environment, subject populations, or collaborative arrangements? **Additional Review Criteria** (not scored individually. but considered in overall impact score): • Protections for Human Subjects • Inclusion of Women. Minorities & Children • Vertebrate Animals • Biohazards • Resubmission • Renewal • Revision **Additional Review Considerations** (not scored individually and not considered in overall score): • Applications from Foreign Organisations • Selected Agents • Resource Sharing Plans • Authentication of Key Biological and/or Chemical Resources

	• Budget & Period of Support
Specific criteria for early-career investigators (first-time applicants):	Yes, see **Scored** and **Additional Review Criteria** and **Additional Review Considerations** above, with the following exceptions: • Investigator(s) If Early Stage Investigators or those in the early stages of independent careers, do they have appropriate experience and training? If established, have they demonstrated an ongoing record of accomplishments that have advanced their field(s)? Does the PD/PI devote 25% or more of his/her research effort on the New Innovator Award project each year? Not applicable are following **Additional Review Criteria**: • Resubmission • Renewal • Revision and following **Additional Review Consideration**: • Applications from Foreign Organisations

Source: Peer review - https://grants.nih.gov/grants/peer-review.htm#Initial, Review criteria - https://grants.nih.gov/grants/peer/critiques/rpg_D.htm, https://grants.nih.gov/grants/policy/review_templates.htm.

Additional information

According to *Stephan, 2012*, p. 131, "the NIH review process puts considerable weight on past accomplishments, which are enumerated on a standardized NIH biosketch form. Results from the previous grant (if there was one) also play an important role in evaluation. The presence of demonstrated expertise and strong preliminary data play an especially key role in the review process. "No crystal, no grant". A major reason that universities provide start-up funds is to permit the newly hired faculty member time to continue the process of collecting preliminary data for an NIH proposal. The "lineage" of the scientist is often noted, in terms of where the scientist trained and in whose lab the scientist did his or her postdoc work. Researchers must also demonstrate that they have adequate space at their university in which to conduct the research." According to a preliminary analysis of the new NIH scoring system, criteria most highly correlated with the overall impact score are approach and significance, lowest were investigator and environment (*Berg*, 2010). The analysis was however only done for the National Institute for the General Medical Sciences, so that the results should be interpreted with care.

Source: https://ofacp.od.nih.gov/about_us/overview.asp.

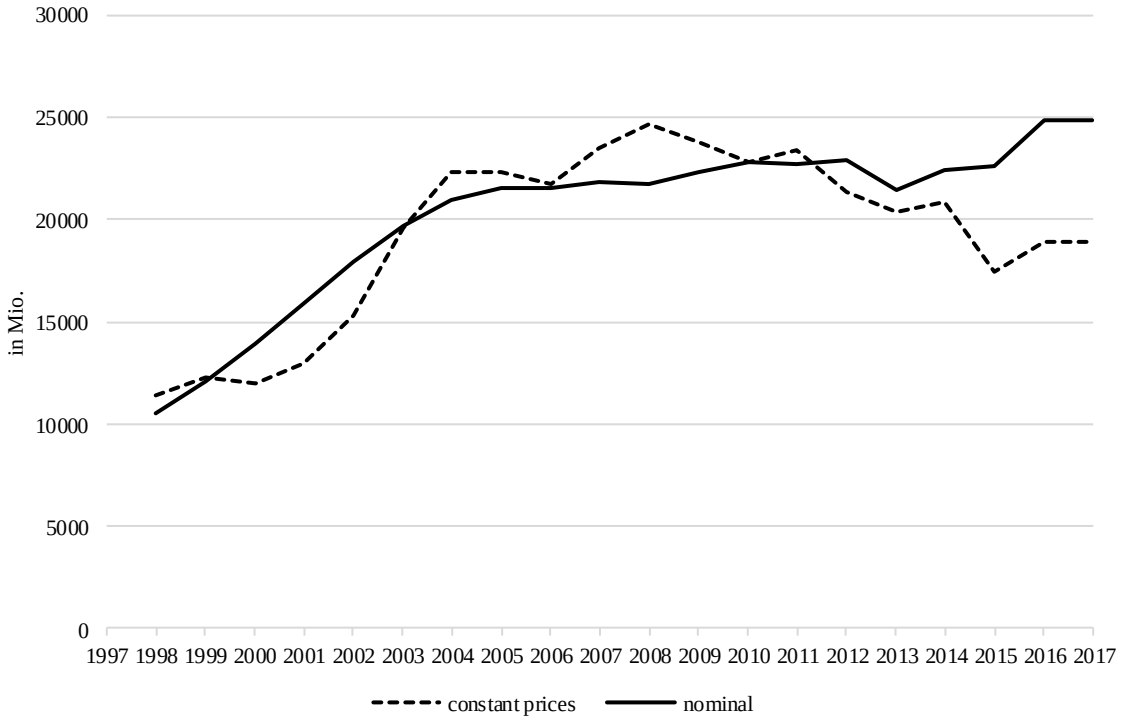
3.7.5 Important changes over time

The following information is partly taken from the NIH website.

Changes at the level of the agency

- Changes in organisational structure: N/A
- Changes in overall funding levels: The NIH budget famously doubled over the period 1998-2002 (see Figure 23) but has evolved in a much less dynamic way since then.

Figure 23: NIH total funding awarded in current and constant USD, 1998-2017



Source: NIH funding facts - https://report.nih.gov/fundingfacts/fundingfacts.aspx, AMECO database for BIP deflator (2010=100), WIFO-calculation. Note: NIH data are only available since 1998.

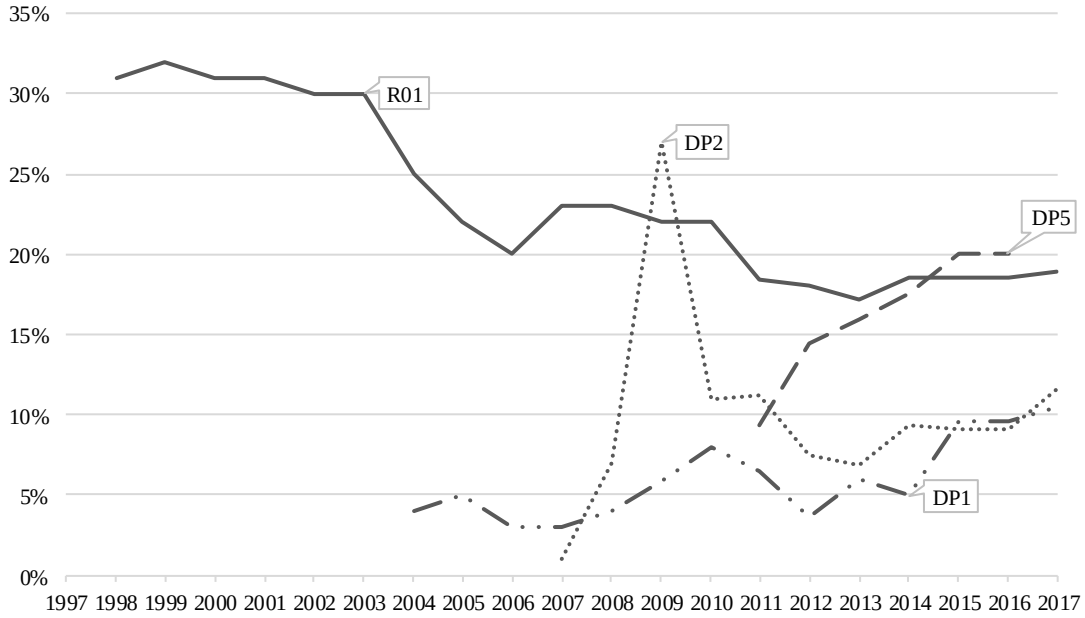
Changes at the level of the individual funding schemes

Funding categories (e.g. Research Career, NRSA Fellowships, etc.) at NIH are defined by certain activity codes, as explained above. However, there might be changes within NIH ICs over the time or general a later implementation of the classification. For instance, Research Projects were first coded to NLM (National Library of Medicine) in fiscal year 2007. The RL5 activity was formerly classified as a Research Project Grant but was reclassified as Other Research in fiscal year 2015. The P42 activity was formerly classified as a Research Project Grant but was reclassified as Research Centers in fiscal year 2017.

Source: Budget and Spending, Research Project Grants - https://report.nih.gov/DisplayRePORT.aspx?rid=541, see footnote.

The figure below shows the significant drop in single project funding success rates since the late 1990'ies, which has not recovered since. Although high-risk and early career show an increasing trend in success rates, they come from a very low level.

Figure 24: Success rate in Single Project Funding (R01), SPF high-risk (DP1 and DP5) and SPF Early career (DP2), 1998-2017



Source: NIH funding facts - https://report.nih.gov/fundingfacts/fundingfacts.aspx.

- Shifts in budget shares between schemes

Similar to other agencies, NIH shows a declining share of the standard single project funding, partly at the benefit of specific project funding schemes with the aims of fostering high risk research or early career researchers, and also in favour of translational and infrastructure spending.

Table 25: NIH shares of funding instruments, change in percentage points between 1998-2017

	Share in 2017	Change of share 1998-2017 in percentage points
Project funding	**67.9%**	**+1.8**
Single project funding (SPF)	50.4%	-1.7
SPF Early career	0.6%	+0.6
SPF high-risk	1.7%	+1.2
Networks and Multi-Project funding	15.2%	+1.7
Interdisciplinary research	0.02%	+0.02
Priority areas	-	-
Structural priority area	-	-
Thematic priority area	-	-
Infrastructure	**4.9%**	**+1.5**
Funding of people	**6.0%**	**+0.1**
Education & Training	2.5%	-0.8
Career	3.4%	+0.8
Diversification	0.1%	+0.1

Prizes	-	-
Mobility	-	-
International Cooperation	**-**	**-**
Translation	**11.8%**	**+2.8**
Applied Research	4.3%	+2.0
R&D Collaboration with firms	3.6%	+1.1
Commercialisation	0.1%	+0.1
R&D Value Chain	3.8%	-0.5
Scientific Communication	**0.7%**	**+0.2**

Source: NIH funding facts - https://report.nih.gov/fundingfacts/fundingfacts.aspx, WIFO calculation.

- Closure of funding schemes, introduction of new funding schemes:

The Common Fund was enacted into law by Congress through the 2006 NIH Reform Act to support cross-cutting, trans-NIH programs that require participation by two or more NIH ICs or would otherwise benefit from strategic planning and coordination. The requirements for the Common Fund encourage collaboration across the ICs while providing NIH with flexibility to determine priorities for Common Fund support. To date, the Common Fund has been used to support a series of short-term, exceptionally high-impact, trans-NIH programs, including the High-Risk, High-Reward Research program, which supports several awards to test new ways of fostering innovation and also was authorized through the Reform Act.

Otherwise, all funding initiatives since 1992 are being kept track of on this website: https://grants.nih.gov/funding/searchguide/index.html. They show that NIH frequently responds to emerging scientific and health challenges, such as AIDS in Africa or most recently the opioid crisis.

Structural changes in allocation of funding (e.g. review procedures, overhead costs, etc.)

Change of NIH peer review system in 2010 (see *Stephan, 2012*), due to complaints about risk aversity of the review process (see also *Azoulay et al., 2011* and the sources cited therein). The new NIH scoring-system uses a 9-point rating scale (1=exceptional; 9=poor); the same scale is used for overall impact scores and for criterion scores. Before the SRG meeting, each reviewer assigned to an application gives a separate score for each of (at least) five review criteria (i.e. Significance, Investigator(s), Innovation, Approach, and Environment) for research grants and cooperative agreements. For all applications, the individual scores of the assigned reviewers and discussant(s) for these criteria are reported to the applicant.

In addition, each reviewer assigned to an application gives a preliminary overall impact score for that application. In many review meetings, the preliminary scores are used to determine which applications will be discussed in full at the meeting. For each application that is discussed at the meeting, a final impact score is given by each eligible committee member (without conflicts of interest) including the assigned reviewers. Each member's score reflects his/her evaluation of the overall impact that the project is likely to have on the research field(s) involved.

The final overall impact score for each discussed application is determined by calculating the mean score from all the eligible members' final impact scores, and multiplying the average by 10; the final overall impact score is reported on the summary statement. Thus, the final overall impact scores range from 10 (high impact) through 90 (low impact). Numerical impact scores are not reported for applications that are not discussed (ND), which may be reported as ++ on the face page of the summary statement and typically rank in the bottom half of the applications.

Source: https://grants.nih.gov/grants/peer-review.htm#Initial.

3.7.6 Information and data sources

Contact at fund

Katrina Pearson

Chief, Statistical Analysis and Reporting Branch – Office of Extramural Research

pearsonk@od.nih.gov

Programme descriptions for NIH institutes and centers:

https://www.nih.gov/about-nih/what-we-do/nih-almanac/nih-organization

Program Overview:

https://grants.nih.gov/grants/how-to-apply-application-guide/forms-e/general/g.130-program-overview.htm

For Success Rates, Award Numbers, Award funding, etc.:

https://report.nih.gov/fundingfacts/fundingfacts.aspx - Excel export for an overall report

https://report.nih.gov/budget_and_spending/index.aspx - Excel files for individual criteria

For project duration (single project funding):

https://report.nih.gov/catalog.aspx - under variables „Project Period"

SBIR/STTR Funding:

https://sbir.nih.gov/funding#phased1

https://grants.nih.gov/grants/guide/parent_announcements.htm#train – Parent Announcements

https://grants.nih.gov/funding/searchguide/index.html - FOAs

3.8 National Science Foundation (NSF, USA)

3.8.1 Organisational mission and structure

Mission focus

Similar to the NIH, NSF also focuses broadly on knowledge creation as well as the impact of the knowledge created on the economy and society. NSF also emphasises support for school-level education to create interest for studying science. The following information is taken from the NSF website:

NSF is the only federal agency whose mission includes support for all fields of fundamental science and engineering, except for medical sciences.

- The mission of NSF is to promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defence.
- NSF's vision is of a Nation that creates and exploits new concepts in science and engineering and provides global leadership in advancing research and education.
- NSF supports research and workforce development programs that help drive future economic growth and enhance our Nation's security and global competitiveness.
- NSF seeks high-risk, potentially transformative research that will generate pioneering discoveries and advance exciting new frontiers in science.
- NSF funds advanced instrumentation and facilities, Arctic and Antarctic research and operations, and cooperative research between universities and industry, and U.S. participation in international scientific efforts.

Source: FY2017 Performance and Financial Highlights - https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf18021, see also https://www.nsf.gov/about/ and https://www.nsf.gov/about/who.jsp.

Overarching decision structures

NSF is a federal agency with external scientists taking on an advisory role, but without a formal say in the agency's decision-making.

It is divided into the following seven directorates that support science and engineering research and education: Biological Sciences, Computer and Information Science and Engineering, Engineering, Geosciences, Mathematical and Physical Sciences, Social, Behavioral and Economic Sciences, and Education and Human Resources. Each is headed by an assistant director, who go through a competitive application process. Within NSF's Office of the Director, the Office of Integrative Activities also supports research and researchers. Other sections of NSF are devoted to financial management, award processing and monitoring, legal affairs, outreach and other functions.

Organisational Chart: https://www.nsf.gov/staff/organizational_chart.pdf.

- General/strategic decision making

The **Office of the Director (OD)** houses the Foundation's top leadership, and oversees all Foundation activities from the development of policy priorities to the establishment of administrative and management guidelines, including long-range planning. The positions of Director and Deputy Director are appointed by the President and confirmed by the U.S. Senate. NSF's statutory authority establishes a six-year term for the Director.

The **Office of Integrative Activities (OIA)** works across disciplinary boundaries to lead and coordinate strategic programs and opportunities that: advance research excellence and innovation; develop human and infrastructure capacity critical to the U.S. science and engineering enterprise; and promote engagement of scientists and engineers at all career stages.

Each federal agency has an **Office of Inspector General (OIG)** that provides independent oversight of the agency's programs and operations. The office is responsible for promoting efficiency and effectiveness in agency programs and for preventing and detecting fraud, waste, and abuse. By statute, the NSF OIG is independent from

the agency, with the IG reporting directly to the National Science Board and the Congress. OIG consults NSF in developing their plans and obtain agency feedback on reports before they are issued. Semi-annually, the OIG submits a summary report of its activities to the Congress, National Science Board, and NSF.

The **National Science Board (NSB)** is made up of 25 Members appointed by the President. The NSF Director is an ex officio Member. Members serve six-year terms. With the exception of the NSF Director, one-third of the Board is appointed every two years. NSB Members are drawn from industry and universities, and represent a variety of science and engineering disciplines and geographic areas. The NSB is apolitical and has two important roles. First, it establishes the policies of NSF within the framework of applicable national policies set forth by the President and the Congress. In this capacity, the Board identifies issues that are critical to NSF's future, approves NSF's strategic budget directions and the annual budget submission to the Office of Management and Budget, and approves new major programs and awards. The second role of the Board is to serve as an independent body of advisors to both the President and the Congress on policy matters related to science and engineering and education in science and engineering. In addition to major reports, the NSB also publishes occasional policy papers or statements on issues of importance to U.S. science and engineering.

Source: https://www.nsf.gov/staff/orglist.jsp.

- Decision structures for funding

Decision structures for funding proposals are quite simple, in that the NSF lacks a second stage discussion among outside external reviewers to decide on funding, as the NSF Program Officer recommends to the Division Director whether the proposal should be declined or recommended for award based on the first-stage review results.

Funding and budget implementation at the aggregate agency level is done by the **Budget Division**, located within the Office of Budget, Finance and Award Management (BFA), which is responsible for the development, analysis, and execution of the Foundation's annual budget to the Office of Management and Budget and the Congress. This responsibility encompasses budget formulation and development, implementation and management of appropriate budget operations and control processes through development of operating plans and special analyses, assisting the development of long-range plans for the Foundation, and assisting the Chief Financial Officer (CFO) and Deputy CFO in the resource management of the Foundation.

The mission of the **Division of Acquisition and Cooperative Support (DACS)** is to provide comprehensive acquisition and cooperative agreement award leadership. DACS is responsible for solicitation, negotiation, award and administration of NSF contracts and of complex cooperative agreements for NSF's research facilities, and major centers' programs such as Science Technology Centers (STC's) and Engineering Research Centers (ERC's). DACS is also responsible for overseeing NSF procurement systems, contracts policy, processes and guidance.

The **Division of Grants and Agreements (DGA)** is responsible for the award of NSF grants and agreements recommended for support by NSF program offices. From pre-award through closeout, DGA conducts a variety of business, financial, and award administrative reviews to ensure compliance with award terms and conditions, NSF policies and procedures, and Federal rules and regulations.

Source: https://www.nsf.gov/bfa/.

Allocation of government funding to agency

The NSF is funded primarily through six Congressional appropriations to which it submits an annual budget request. Research & Related Activities (R&RA), Education & Human Resources (HER) and Major Research Equipment & Facilities Construction (MREFC) fund the agency’s programmatic activities and account for 95 percent of NSF’s total appropriations. The Agency Operations & Award Management (AOAM) appropriation provides funds to administer and manage those programmatic activities. Separate appropriations are provided to support the activities of the Office of Inspector General (OIG) and National Science Board (NSB).

Source: FY2017 Performance and Financial Highlights - https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf18021.

Organisation of funding activities

The NSF allocates money through common funding schemes (see table below) for seven discipline-specific directorates (research areas).

3.8.2 Overview of funding schemes

The following information is taken from the NSF website.

At NSF proposals may be submitted in response to the various funding opportunities that are announced on the NSF website. These funding opportunities fall into three categories -- program descriptions, program announcements and program solicitations -- and are the mechanisms NSF uses to generate funding requests (for a full list of funding schemes, see: https://www.nsf.gov/funding/azindex.jsp).

In addition to standard research proposals, there are other types of proposals that may be submitted to NSF[7]:

- **Rapid Response Research (RAPID) Proposal:** RAPID is a type of proposal used when there is a severe urgency with regard to availability of, or access to, data, facilities or specialized equipment, including quick-response research on natural or anthropogenic disasters and similar unanticipated events.
- **Early-concept Grants for Exploratory Research (EAGER) Proposal:** EAGER is a type of proposal used to support exploratory work in its early stages on untested, but potentially transformative, research ideas or approaches. This work may be considered especially "high risk-high payoff" in the sense that it, for example, involves radically different approaches, applies new expertise, or engages novel disciplinary or interdisciplinary perspectives.
- **Research Advanced by Interdisciplinary Science and Engineering (RAISE) Proposal:** RAISE is a type of proposal that may be used to support bold, interdisciplinary projects whose scientific advances lie in great part outside the scope of a single program or discipline, such that substantial funding support from more than one program or discipline is necessary; whose lines of research promise transformational advances; whose prospective discoveries reside at the interfaces of disciplinary boundaries that may not be recognized through traditional review or co-review.
- **Grant Opportunities for Academic Liaison with Industry (GOALI) Proposal:** GOALI is a type of proposal that seeks to stimulate collaboration between academic research institutions and industry. Under this proposal type, academic scientists and engineers request funding either in conjunction with a regular proposal submitted to a standing NSF program or as a supplemental funding request to an existing NSF-funded award. GOALI is not a separate program.
- **Ideas Lab Proposal:** "Ideas Lab" is a type of proposal to support the development and implementation of creative and innovative project ideas that have the potential to transform research paradigms and/or solve intractable problems. An Ideas Lab may be run independently, or in parallel, with the issuance of an NSF funding opportunity on the same topic. These project ideas typically will be high-risk/high-impact, as they represent new and unproven ideas, approaches and/or technologies. This mechanism was developed collaboratively within NSF, modeled on the "sandpit" workshops that are a key component of the United Kingdom Research Council's "IDEAs Factory" program.
- **Facilitation Awards for Scientists and Engineers with Disabilities (FASED):** to reduce or remove barriers to participation in research and training by persons with physical disabilities by providing special equipment and assistance under awards made by NSF; and to encourage persons with disabilities to pursue careers in science and engineering by stimulating the development and demonstration of special equipment that facilitates their work performance.
- **Conference Proposals:** NSF supports conferences in special areas of science and engineering that bring experts together to discuss recent research or education findings or to expose other researchers or students to new research and education techniques. NSF encourages the convening in the US of major international conferences.
- **Equipment Proposals:** A proposal for specialized equipment may be submitted by an organization for: individual investigators; groups of investigators within the same department; several departments; organization(s) participating in a collaborative or joint arrangement; any components of an organization; or a region.

[7] For more detailed information, see https://www.nsf.gov/pubs/policydocs/pappg18_1/pappg_2.jsp#IIE6, Chapter E. Types of proposals.

- **Travel proposal:** A proposal for travel support, either domestic and/or international, for participation in scientific and engineering meetings are handled by the NSF organizational unit with program responsibility for the area of interest.
- **Center proposal:** NSF provides support for a variety of individual Centers and Centers programs that contribute to the Foundation's vision as outlined in the NSF Strategic Plan.
- **Research Infrastructure Proposal:** As an integral part of its responsibility for strengthening the science and engineering capacity of the country, NSF provides support for the design, construction, operation and upgrade of research infrastructure including instrumentation, mid-scale projects and major facilities.

3.8.3 Overview of funding schemes

At any time, scientists and engineers are also welcome to send in **unsolicited proposals** for research and education projects, in any existing or emerging field (see https://www.nsf.gov/about/how.jsp). Research topic origin: Proposal topic is investigator-initiated ("bottom-up") or proposed by science fund ("top-down").

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Research	Research	Single project funding (SPF)	yes	bottom-up/ top-down	Project	The "Research" Category involves different kinds of single-project funding, among them standard research grants, but also more specific mechanisms such as RAPID (see list above)	https://www.nsf.gov/funding/azindex.jsp https://www.nsf.gov/pubs/policydocs/pappg18_1/pappg_2.jsp#IIE, see E. Types of proposals
CAREER	CAREER	Career	yes	bottom-up/ top-down	Person	The Faculty Early Career Development (CAREER) Program is a Foundation-wide activity that offers the National Science Foundation's most prestigious awards in support of early-career faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization.	https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503214
Centers	Centers	Interdisciplinary research	yes	N/A	Project	NSF supports a variety of centers programs that contribute to the Foundation's mission and vision. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research program or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers are a principle means by which NSF fosters interdisciplinary research.	https://www.nsf.gov/about/partners/centers.jsp
SBIR/STTR	SBIR/STTR	R&D collaboration with firms	yes	bottom-up	Firms / Project	The Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR) programs provide proof-of-concept / feasibility grants for early stage, high-tech small businesses which could potentially be followed by grants to undertake cutting-edge, high-quality scientific research and development to de-risk their technologies.	https://www.nsf.gov/eng/iip/about.jsp
Education	Education	Education & Training	yes	N/A	Person	Besides the activities in EHR (see below), nearly all NSF research components support education or training programs aimed at students of all levels, as well as out-of-school populations. That includes support for potential innovators who will contribute to our nation's scientific and technical knowledge, those who plan to pursue careers in science and technology (including teaching) and those who will enhance our understanding of the societal influences and impacts of science and technology as a foundation for responsible citizenship.	https://www.nsf.gov/news/overviews/education/overview.jsp

Broad-level funding scheme	Name of funding scheme	Classification of scheme according to the structure proposed by study authors	Funding scheme is discipline-specific	Choice of research question ("bottom-up" or "top-down")	Who gets funded	Main aim of funding scheme	Link
Education & Human Resources (EHR)	Education & Human Resources (EHR)	Education & Training	N/A	N/A	Person	The mission of EHR is to achieve excellence in U.S. science, technology, engineering and mathematics (STEM) education at all levels and in all settings (both formal and informal) in order to support the development of a diverse and well-prepared workforce of scientists, technicians, engineers, mathematicians and educators and a well-informed citizenry that have access to the ideas and tools of science and engineering. The purpose of these activities is to enhance the quality of life of all citizens and the health, prosperity, welfare and security of the nation.	https://www.nsf.gov/ehr/about.jsp
	Programs to Broaden Participation	Diversification	yes	N/A	Person / Institution	Broadening participation infuses science and engineering excellence into varied individual, institutional, and geographic networks and provides for the discovery and nurturing of talent wherever it may be found. Additionally, NSF defines broadening participation in terms of individuals from underrepresented groups (i.e., women, underrepresented minorities, and persons with disabilities) as well as institutions (i.e., women's colleges, minority-serving institutions, and institutions primarily serving persons with disabilities) and geographic areas (i.e., rural, urban and EPSCoR jurisdictions) that do not participate in NSF research programs at rates comparable to others.	https://www.nsf.gov/about/budget/fy2019/pdf/13_fy2019.pdf
	Infrastructure	Infrastructure	yes	N/A	Project	N/A	N/A
	Major Research Equipment & Facilities Construction (MREFC)	Infrastructure	N/A	N/A	Project	The MREFC supports the acquisition, construction and implementation of a large research infrastructure that offers unique opportunities at the borders of science and technology.	https://www.nsf.gov/about/budget/fy2019/pdf/34_fy2019.pdf

Source: See Tables on this website, https://www.nsf.gov/about/budget/.

3.8.4 Characteristics of funding schemes

Standard research grants dominate within NSF's funding portfolio; single project funding should be interpreted with care, as many different grant mechanisms (see above, e.g. RAPID, EAGER, etc.) are summarised within this category. NSF shows a large role for infrastructure spending, as well as for education & training. Career and translational schemes play a much smaller role by comparison. Note however that all research proposals to NSF are also reviewed according to potential impact (see section 3.7.4.), so that a translational perspective is built into the standard research grants. Funding by discipline shows that close to half of all funds go to natural sciences, followed by engineering, interdisciplinary research and social sciences and humanities. Note that the NSF is only one of the main US grant-based research funding organisations and that medicine is funded by NIH, so that the funding portfolio in terms of disciplines needs to be assessed together with the NIH (see section 4). The NSF funding data does not show the thematic focus of its funding schemes, as it is aggregated at a very broad level, e.g. research vs. careers. However, the NSF follows a number of thematic priorities which present in an exemplary way from the budget requests 2016 and 2019:

Foundation-wide programs and priorities of NSF bring together researchers from all fields of science and engineering. Some of these interdisciplinary investments are listed below[8].

The following information is taken from the NSF website:

- **Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS)** aims to understand, design, and model the interconnected food, energy, and water system through an interdisciplinary research effort that incorporates all areas of science and engineering and addresses the natural, social, and human-built factors involved.
- **NSF Innovation Corps (I-Corps™)** improves NSF-funded researchers' access to resources that can assist in bridging the gap between discoveries and technologies, helping to transfer knowledge to downstream technological applications and use at scale.
- **Secure and Trustworthy Cyberspace (SaTC)** investment aims to build the knowledge base in cybersecurity that enables discovery, learning, and innovation, and leads to a more secure and trustworthy cyberspace.
- **Understanding the Brain (UtB)** encompasses ongoing cognitive science and neuroscience research and NSF's contributions to the ongoing Brain Research through Advancing Innovation and Neurotechnologies (BRAIN) Initiative. The goal of UtB is to enable scientific understanding of the full complexity of the brain, in action and in context.
- **Clean Energy Technology** investments support research and education in alternative energy for electricity (solar, wind, wave, geothermal) and fuels (chemical and biofuels).
- **Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS)** aims to integrate a number of science and engineering activities across the Foundation – breakthrough materials, advanced manufacturing, robotics, and cyber-physical systems. It will address pressing technological challenges facing the Nation and promote U.S. manufacturing competitiveness.
- **Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21)** accelerates and transforms the process of scientific discovery and innovation by providing advanced cyberinfrastructure and new capabilities in computational and data-enabled science and engineering.
- **NSF Research Traineeship (NRT)** aims to identify priority research themes that both align with NSF priority research activities and have strong potential in areas of national need where innovative practices in graduate education can be developed.
- **Research at the Interface of Biological, Mathematical, and Physical Sciences (BioMaPS)** involves the Directorates for Biological Sciences, Mathematical and Physical Sciences, and Engineering, and it seeks to advance discovery at the intersections of these established disciplines.

[8] For more Foundation-wide programs and priorities, see NSF's Budget and Performance Site: https://www.nsf.gov/about/budget/.

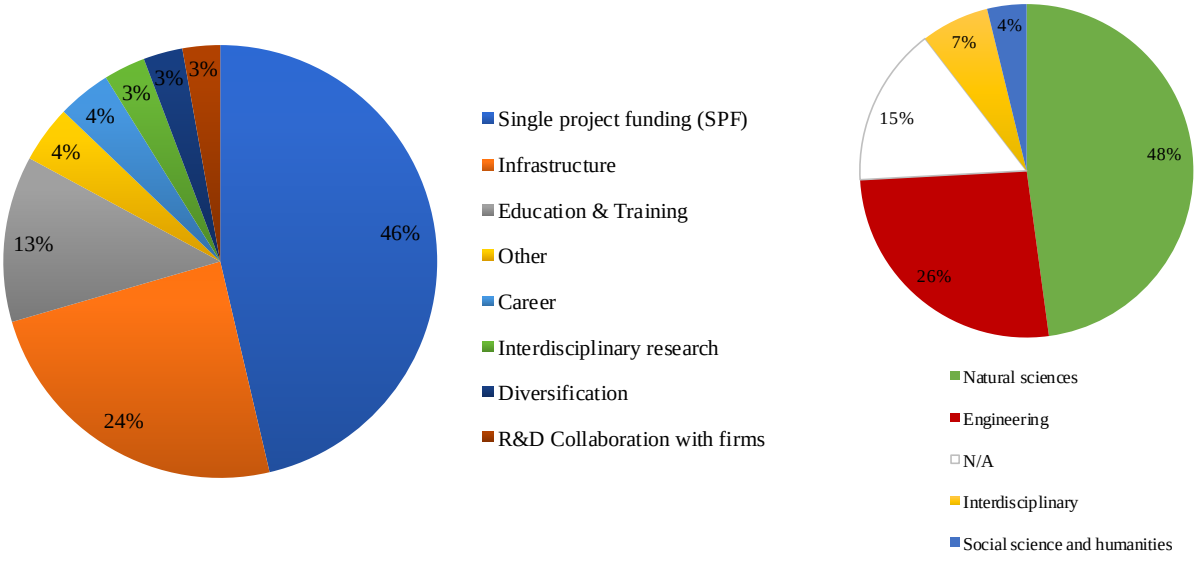
- **Science, Engineering, and Education for Sustainability (SEES)** aims to increase understanding of the integrated system of supply chains, society, the natural world, and alterations humans bring to Earth, in order to create a sustainable world.

Source: FY 2019 Budget Request to Congress, https://www.nsf.gov/about/budget/fy2019/pdf/fy2019budget.pdf; FY 2016 Budget Request to Congress, https://www.nsf.gov/about/budget/fy2016/pdf/fy2016budget.pdf.

For the $5.7 billion of obligations for R&D in FY2015, 87.7% was for basic research and 12.3% for applied research.

Source: Table 4-17, https://www.nsf.gov/statistics/2018/nsb20181/report/sections/research-and-development-u-s-trends-and-international-comparisons/recent-trends-in-federal-support-for-u-s-r-d.

Figure 25: NSF total awarded funding according to study author classification (left panel) and shares of disciplines on total awarded funding (right panel), 2017



Source: NSF, WIFO calculation. Note: The category "Other" (left panel) includes expenditure that cannot be classified according to the classification. The category "N/A" (right panel) includes expenditure that cannot be classified according to the research disciplines.

The next table shows that in terms of grant design characteristics and success rates, there is only little information at the level of broad funding types. Success rates in the main research grants funding scheme are low at 21%.

Table 26: Selected characteristics of the funding schemes, 2017

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
Total		**100%**	**N/A**	**0.55**	**N/A**	**N/A**	**23%**
Project funding		**49%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Single project funding (SPF)	Research	46%	average: 0.15 Mio. EUR	0.34	average: 2.9 years	N/A	21%
SPF Early career		-	-	-	-	-	-
SPF high-risk		-	-	-	-	-	-
Networks and Multi-Project funding		-	-	-	-	-	-
Interdisciplinary research	Centers	3%	N/A	N/A	10 years	N/A	N/A
Priority areas		-	-	-	-	-	-

Funding scheme according to study scheme classification	Original name of the scheme	Share of scheme in total funding	Lot size (according to application documents) in Mio. EUR	Lot size (statistical*) in Mio. EUR	Duration of funding (according to proposal guidelines)	Duration of funding (statistical*)	Success Rate
Structural priority area		-	-	-	-	-	-
Thematic priority area		-	-	-	-	-	-
Infrastructure		**24%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
	Infrastructure	21%	N/A	N/A	N/A	N/A	N/A
	Major Research Equipment	3%	3.5 Mio. EUR	N/A	max. 3 years (for acquisition proposals) and max. 5 years (for development proposals)	N/A	N/A
Funding of people		**19%**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Education & Training		12%	N/A	N/A	N/A	N/A	N/A
	Education	3%	N/A	N/A	N/A	N/A	N/A
	Education & Human Resources	9%	N/A	N/A	N/A	N/A	N/A
Career	CAREER	4%	0.07 or 0.89 Mio. EUR/year**	N/A	5 years	N/A	N/A
Diversification	Programs to Broaden Participation	3%	N/A	N/A	N/A	N/A	N/A
Prizes		-	-	-	-	-	-
Mobility		-	-	-	-	-	-
International Cooperation		**-**	**-**	**-**	**-**	**-**	**-**
Translation		**3%**	**see R&D collaboration with firms**	**N/A**	**see R&D collaboration with firms**	**N/A**	**N/A**
Applied Research		-	-	-	-	-	-
R&D Collaboration with firms	SBIR/STTR	3%	Phase 1: 0.2 Mio. EUR Phase 2: 0.66 Mio. EUR	N/A	Phase 1: 6-12 months Phase 2: 2 years	N/A	N/A
Commercialisation		-	-	-	-	-	-
R&D Value Chain		-	-	-	-	-	-
Scientific Communication		**-**	**-**	**-**	**-**	**-**	**-**

Source: NSF Budget Requests to Congress and Annual Appropriations, https://www.nsf.gov/about/budget/index.jsp. Note: Lot size is the size of the total grant (the total amount of money granted for the researcher's proposal) which will usually be consumed over a period of several years (funding duration). Lot size according to application documents is the maximum amount of money researchers can ask for (or the minimum-maximum range); Lot size statistical is the actual average amount of money paid out for granted projects. Lot sizes have been converted from USD to EUR. Exchange rate from January 1, 2017: 0.89. Minor deviations due to rounding. Success rates are the share of granted applications relative to the total number of full applications. A "-"-sign indicates that data/the scheme do not exist at all ; "N/A" indicates that an assessment category is not applicable to the individual funding scheme, or that data are not available. *calculated by WIFO. ** depends on the discipline: BIO, ENG, OPP min. 500,000 Dollars (approx. 443,000 Euro) for 5 years.

Concerning funding duration, grants can be renewed, but they compete with all the other (first-time and other renewal) proposals without any difference, i.e. there is no different review process and it is not easier to get a grant renewed than to get a project funded for the first time. An exception are "accomplishment-based" renewals (ABR), which are granted on the basis of publications and human resources development in the project to be renewed. ABRs are only granted once.

There is also data available on Early and Later Career Principal Investigators (PIs), showing that the success rates of early career PIs is generally lower than the one of later career PIs, in accordance with the literature (section 2) and the known difficulties of proposal writing which favour established researchers.

Table 27:Percentage and Success Rate of NSF Early and Later Career PIs, 2001-2015

	Early Career PI		**Later Career PI**	
	Count Percentage	*Success Rate*	*Count Percentage*	*Success Rate*
2015	21%	19%	79%	23%
2014	21%	18%	79%	21%
2013	22%	18%	78%	20%
2012	21%	18%	79%	22%
2011	23%	16%	77%	19%
2010	22%	18%	78%	22%
2009	24%	25%	76%	29%
2008	24%	19%	76%	22%
2007	25%	20%	75%	23%
2006	24%	19%	76%	22%
2005	23%	17%	77%	21%
2004	22%	17%	78%	22%
2003	22%	20%	78%	25%
2002	22%	21%	78%	29%
2001	22%	23%	78%	28%

Source: data.gov - https://catalog.data.gov/dataset/nsf-early-and-later-career-principal-investigators-pis-count-and-funding-rates. Note: "Count Percentage" indicates the percentage share of early or later career PIs on total funded grants. Early Career = PIs who received their last degree within seven years at the time of the award; Later Career = PIs who received their last degree more than seven years before the time of their first NSF award.

3.8.5 Refundable costs and review procedures of single project funding

The following costs will be refunded:

- Wage(s) of the applicant(s)/PI
- Wages of scientific/technical staff,
- Material expenses (i.e. Costs for equipment and materials of permanent value, direct costs for the use of infrastructures (including costs for maintenance and care), consumables, field expenses, computing time and data (cloud computing), costs for making research data accessible (open research data),
- Mobility (Travel (incl. accommodation and catering costs), conferences and workshops,
- Third-party expenses (Costs of project partners (not wages), consulting, consortia, outsourcing through subcontracting); Costs of scientific (open access) publications,
- administrative/indirect costs (e.g. depreciation; maintenance; library costs; interest on debt; general administrative expenses; departmental administrative expenses; sponsored projects administration; and student administration expenses, from *Stephan, 2012*)

- Indirect cost rate (overheads): 100% of indirect costs

Same as for the NIH, research institutions in the US can have their full indirect costs reimbursed for all federal research grants: in 2010. the indirect cost rate (the indirect costs relative to the direct costs) amounted to 29.8-69% of the direct cost of research (*Sale and Sale, 2010*). Universities calculate the indirect costs they ask for themselves, subject to an audit by the agency and to guidelines by the OMB (Office of Management and Budget), it is not determined by the agencies. This is a time-consuming process which is updated every three years (*Stephan, 2012*).

Further information at https://www.nsf.gov/bfa/dias/caar/indirect.jsp.

Source: Allowability of Costs - https://www.nsf.gov/pubs/policydocs/pappguide/nsf13001/aag_5.jsp.

Table 28: Overview of review process

The following information is taken from the NSF website.

Internal/External reviewers:	both
Number of reviewers (per proposal):	at least one internal reviewer and three external reviewers (in practice 3-10)
International/National reviewers:	mostly national
Organisation of Review:	**1st stage: either ad hoc (mail), panel review** or combination of both organised by NSF Program Officer who selects external peer reviewers; **2nd stage**: After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the Division Director whether the proposal should be declined or recommended for award. Applicants will get all the information coming from the reviews, except the names of the reviewers.
Assessment criteria (incl. weights or relative importance, if available):	**Merit review criteria:** • Intellectual Merit (encompasses the potential to advance knowledge) • Broader Impacts (encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes) The following elements should be considered in the review for both criteria: 1. What is the potential for the proposed activity to: a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and b. Benefit society or advance desired societal outcomes (Broader Impacts)? 2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts? 3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success? 4. How well qualified is the individual, team, or organization to conduct the proposed activities? 5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities? The NSF Program Officer may in addition examine other factors, e.g. different approaches to significant research and education questions; potential (with perhaps high risk) for transformational advances in a field; capacity building in a new and promising research area; or achievement of special program objectives
Special characteristics for early stage researchers (first-time applicants):	N/A

Source: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Additional information

According to *Stephan, 2012*, p. 132f., "NSF peer review follows a slightly different process [to NIH]. Investigators submit proposals to programs, which are generally organized around fields of study. Programs vary as to whether they use mail reviews exclusively or panel reviews supplemented by mail reviews to evaluate proposals. Reviewers rank proposals on a five-point scale that goes from Excellent to Poor….

Unlike the case of NIH, program officers have considerable discretion in making funding decisions, especially with regard to proposals that fall between a "clearly fund" and a "clearly do not fund." There is not a tradition of continuing a grant at NSF, as there is at NIH, although researchers can and do submit proposals for follow-on research. NSF has the appearance of putting less emphasis on reputation than does NIH and limits the number of publications the researcher can list to a maximum of ten….

[The success rate] also depends on NSF policies with regard to size of award and length of award. In an effort to "increase productivity by minimizing the time PIs spent writing multiple proposals and managing administrative tasks" NSF tried to extend the length of the average grant and increase the size of the grant. Between 2000 and 2005 the average size of an award increased by 41%; the average length of an award stayed approximately the same, at almost exactly three years. Success rates plummeted as more proposals chased fewer grants."

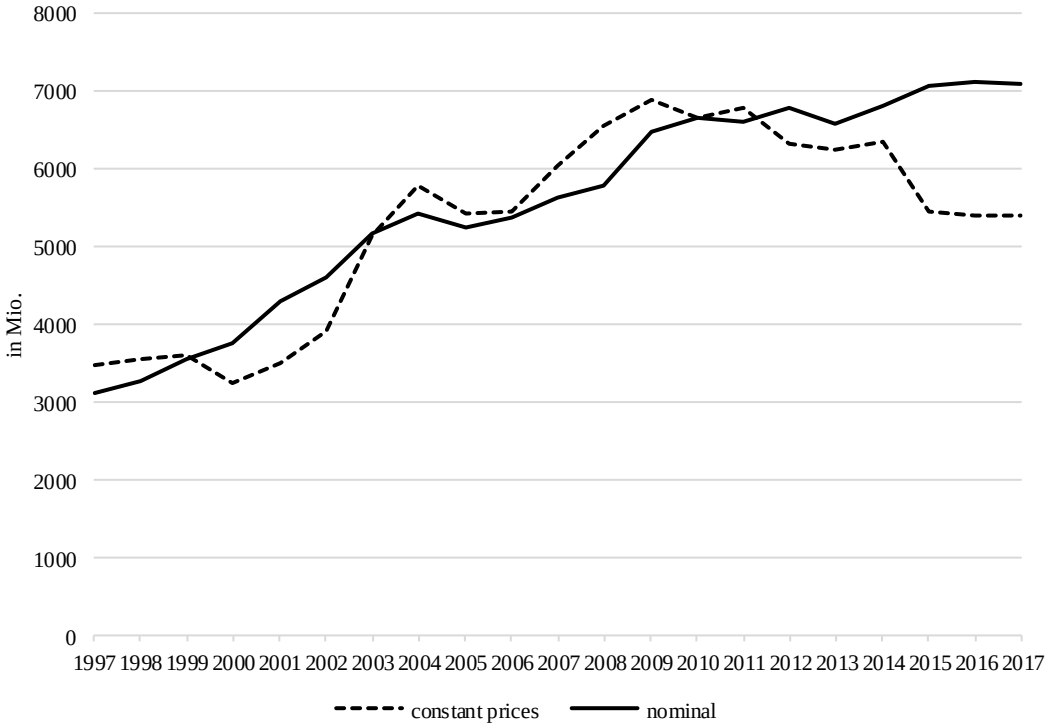
Source: Stephan, 2012, p. 132f.

3.8.6 Important changes over time

Changes at the level of the agency

- Changes in organisational structure: N/A
- Changes in overall funding levels: The NSF budget or total funding awarded has since 2009/10 seen a rather flat development, leading even to a decrease when measured at constant dollars.

Figure 26: NSF total funding awarded in current and constant USD, 1997-2017

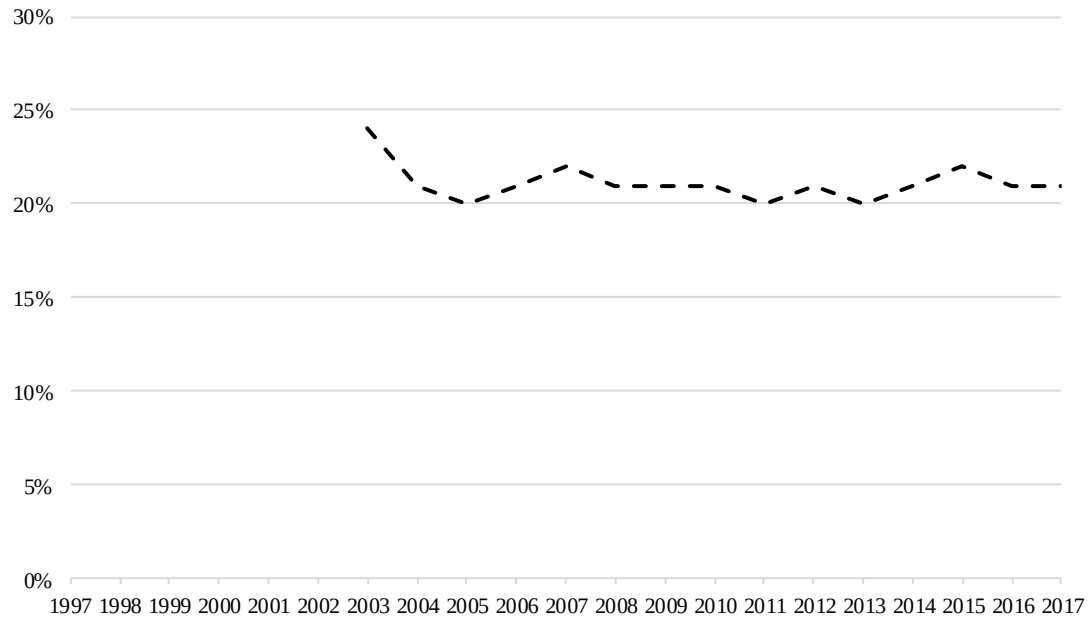


Source: NSF Budget Requests - https://www.nsf.gov/about/budget/index.jsp, AMECO database for BIP deflator (2010=100), WIFO calculation.

Changes at the level of the individual funding schemes

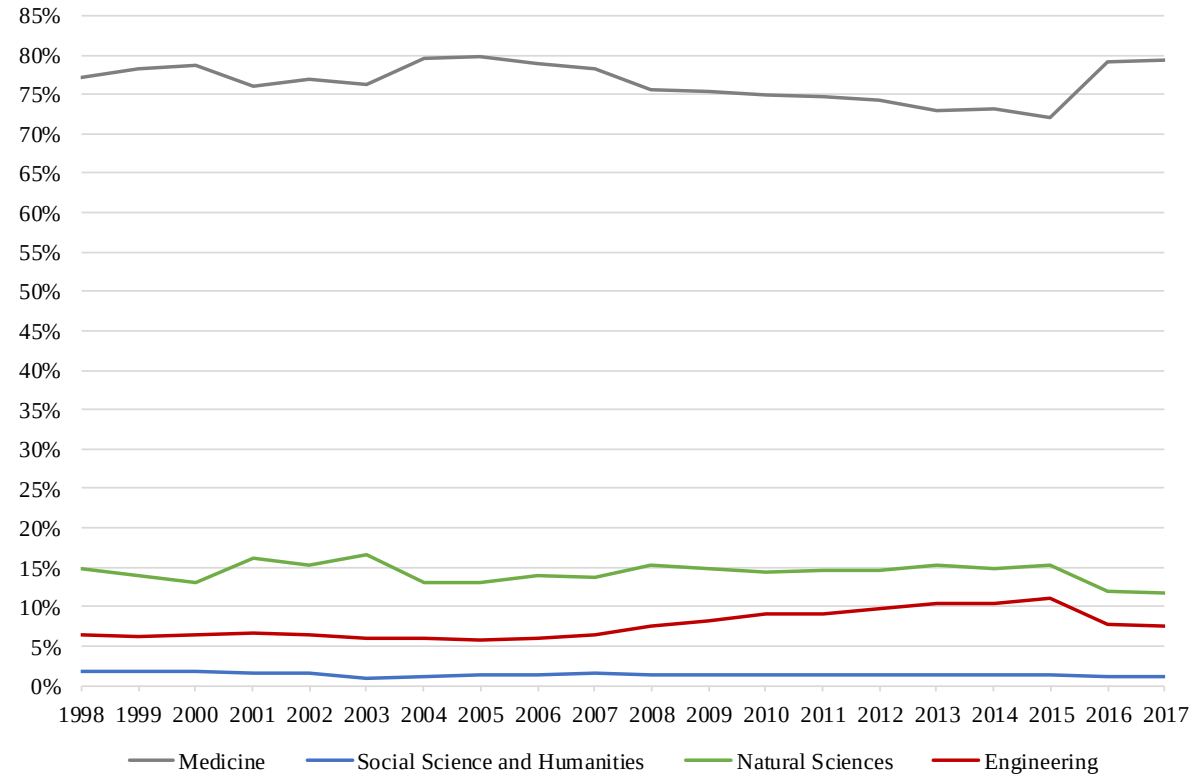
The success rate in the main research grant mechanism has declined somewhat since the early 2000's, but has since been rather stable, at a rather low level however.

Figure 27: Success rate in Single Project Funding, 2003-2017



Source: NSF Budget Requests - https://www.nsf.gov/about/budget/index.jsp.

Figure 28: Total awarded funding in Single project funding by discipline – United States, 1998-2017



Source: Annual Reports and Data of agencies (NIH & NSF).

- Shifts in budget shares between schemes

NSF shows a particularly strong increase of infrastructure spending.

Table 29: NSF shares of funding instruments, change in percentage points between 1997-2017

	Share in 2017	Change of share 1997-2017 in percentage points
Project funding	**49.5%**	**-10.7**
Single project funding (SPF)	46.3%	-5.3
SPF Early career	-	-
SPF high-risk	-	-
Networks and Multi-Project funding	-	-
Interdisciplinary research	3.1%	-5.4
Priority areas	**-**	**-**
Structural priority area	-	-
Thematic priority area	-	-
Infrastructure	**24.1%**	**+9.2**
Funding of people	**19.3%**	**-1.2**
Education & Training	12.4%	-5.1*
Career	4.0%	+1.0
Diversification	2.9%	+2.9
Prizes	-	-
Mobility	-	-
International Cooperation	**-**	**-**
Translation	**2.8%**	**-0.2**
Applied Research	-	-
R&D Collaboration with firms	2.8%	-0.2
Commercialisation	-	-
R&D Value Chain	-	-
Scientific Communication	**-**	**-**

Source: NSF Budget Requests - https://www.nsf.gov/about/budget/index.jsp, WIFO calculation. Note: * change of share 2017-2010 in percentage points.

- Closure of funding schemes, introduction of new funding schemes: See the description of research grant mechanisms above.

Structural changes in allocation of funding (e.g. review procedures, overhead costs, etc.): N/A

3.8.7 Information and data sources

Contact at fund

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Various datasets of the NSF:

https://catalog.data.gov/organization/nsf-gov

https://www.nsf.gov/statistics/srvyfedfunds/

https://www.nsf.gov/statistics/srvyfedsupport/

Information about Research Projects Single PIs and MPIs:

see Merit Review Reports: https://www.nsf.gov/nsb/publications/pubmeritreview.jsp

For Funding, Success Rate, Lot size and project duration, etc.:

NSF Budget Requests to Congress and Annual Appropriations: https://www.nsf.gov/about/budget/index.jsp.

4. (Basic) research grant funding in international comparison

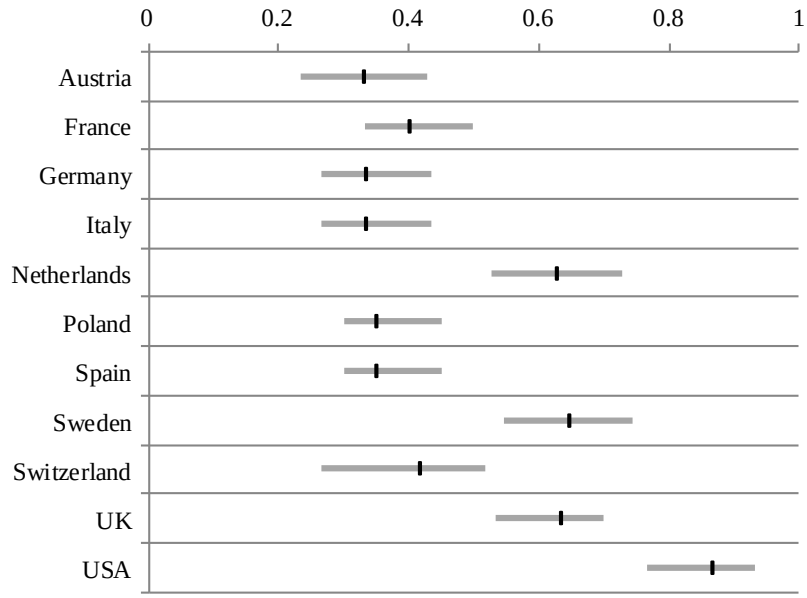
This section puts the findings from section 3 in a comparative context and provides in addition statistical data to situate the research funding agencies' activities. It provides all the information necessary for the synthesis in section 5, which will look at structural differences between the DFG and other agencies, as well as at the potential impact of structural differences on research outcomes. We set out with a brief description of the context for the agencies' activities, in terms of the structure of higher education systems, the funding landscape for higher education research, differences in the mission and organisational structure of the agencies and finally the research "performance" of the different countries.

4.1 The context for the activities of science funding organisations

4.1.1 Structure of higher education systems

The impact of basic research grant funding may be influenced by the research organisation at working unit level and the structure of career paths. Regarding careers, a high share of non-tenured researchers, or researchers on fixed-term contracts, may lead to more risk-averse strategies in a country (see review of the literature in section 2). Recent work in comparative higher education (*Janger et al., 2013*) has tried to systematically characterise the attractiveness of research institutions for researchers, taking account of career perspectives, which include the share of non-tenured researchers below the level of full professor and the prevalence of the tenure track model. Figure 29 and Table 30 present the results, which show that Germany and also Switzerland feature higher shares of fixed-term researchers, due to their chair-based university models (see research organisation below) which feature a full professor at the top and a range of often non-tenured researchers at the "bottom" of the institutes. The Netherlands, the UK and the US feature higher shares of tenured researchers, although this picture may have changed in particular for the US.

Figure 29: Career attractiveness index (0 – not attractive, 1 – very attractive)



Source: *Janger et al.*, 2013.

Table 30: Career perspectives index and its constituting components (0 – not attractive, 1 – very attractive)

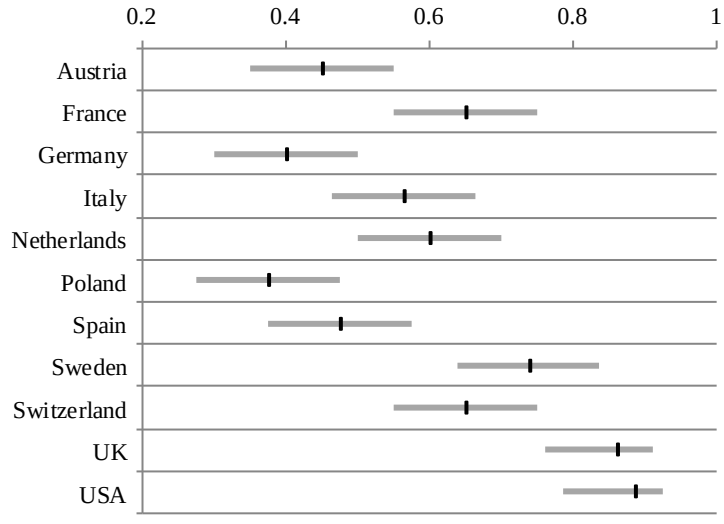
	Index career perspectives			Share of tenured researchers below full professor			Ability to teach in English			Existence of tenure-track model			Characteristics of tenure-track model			Recruitment procedure for tenure track positions		
	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Austria	0.33	0.23	0.43	0.40	0.30	0.50	0.50	0.40	0.60	0.09	0.00	0.19	0.25	0.00	0.35	0.90	0.80	1.00
France	0.40	0.33	0.50	0.80	0.70	0.90	0.40	0.30	0.50	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.10
Germany	0.33	0.27	0.43	0.20	0.20	0.30	0.50	0.40	0.60	0.30	0.20	0.40	1.00	0.90	1.00	1.00	0.90	1.00
Italy	0.33	0.27	0.43	0.70	0.60	0.80	0.30	0.20	0.40	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.10
Netherlands	0.63	0.53	0.73	0.60	0.50	0.70	0.80	0.70	0.90	0.48	0.38	0.58	0.80	0.70	0.90	1.00	0.90	1.00
Poland	0.35	0.30	0.45	0.80	0.70	0.90	0.25	0.20	0.35	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.10
Spain	0.35	0.30	0.45	0.80	0.70	0.90	0.25	0.20	0.35	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.10
Sweden	0.65	0.55	0.75	0.70	0.60	0.80	0.90	0.80	1.00	0.34	0.24	0.44	0.80	0.70	0.90	0.60	0.50	0.70
Switzerland	0.42	0.27	0.52	0.40	0.30	0.50	0.60	0.50	0.70	0.25	0.00	0.35	1.00	0.90	1.00	1.00	0.90	1.00
UK	0.63	0.53	0.70	0.60	0.50	0.70	1.00	0.90	1.00	0.30	0.20	0.40	0.60	0.50	0.70	1.00	0.90	1.00
USA	0.87	0.77	0.93	0.70	0.60	0.80	1.00	0.90	1.00	0.90	0.80	1.00	1.00	0.90	1.00	1.00	0.90	1.00
Mean	0.48	0.39	0.57	0.61	0.52	0.71	0.59	0.50	0.67	0.24	0.17	0.34	0.50	0.42	0.57	0.59	0.53	0.65

Source: *Janger et al.*, 2013.

Competitive grant funding may on the other hand actually be beneficial for researchers in hierarchically organized working units (chairs), such as in Germany (see Table 31 and Figure 30), as they allow them to achieve research autonomy and independence even when they are not yet full professor; however, they may be risk-averse when not on a tenured position. The analysis of research organisation also includes the accessibility of university-internal funds for early stage researchers which face difficulties in applying for competitive grant funding. Here, Switzerland obtains the highest score after Sweden, while Germany is below the mean.

An important aspect not covered in this work is how much researchers are expected to apply for grant funding. In the US, according to *Stephan 2012*, finding resources for research at U.S. universities has become the responsibility of faculty members. Tenured researchers can use grant funds to buy out part or all of their teaching time and cover their summer salary, whereas non-tenured researchers are expected to cover most if not all of their salary. The amount of "pressure" for acquiring research grants in EU institutions would have to be researched, but it is probably safe to say that there is not as much pressure, in particular given the size of block funding (see section 4.1.2).

Figure 30: Research organisation attractiveness index (0 – not attractive, 1 – very attractive)



Source: *Janger et al.*, 2013.

Table 31: Research organisation index and its constituting components

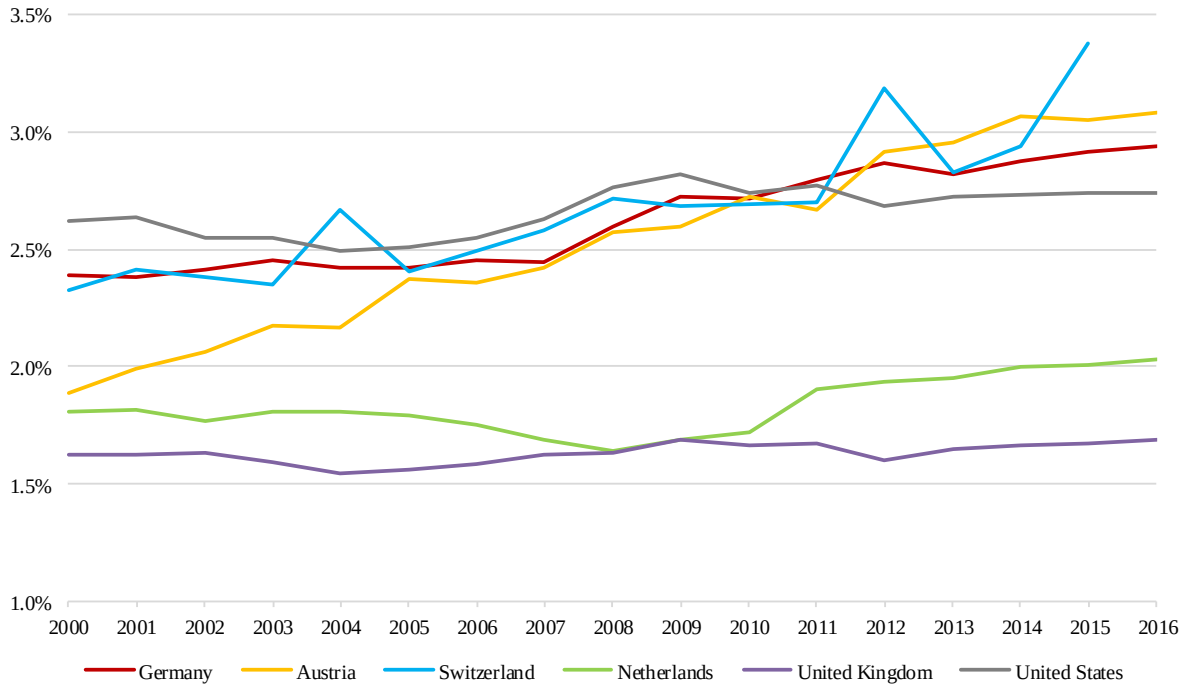
	Index research organisation			Research autonomy of first position of academic career			Accessibility of university funds to ESR (financial autonomy)			Organisation of working units			Recruitment of researchers for first position in academic career vs. recruitment of full professor		
	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Austria	0.45	0.35	0.55	0.50	0.40	0.60	0.50	0.40	0.60	0.40	0.30	0.50	0.40	0.30	0.50
France	0.65	0.55	0.75	0.80	0.70	0.90	0.40	0.30	0.50	0.70	0.60	0.80	0.70	0.60	0.80
Germany	0.40	0.30	0.50	0.50	0.40	0.60	0.40	0.30	0.50	0.30	0.20	0.40	0.40	0.30	0.50
Italy	0.56	0.46	0.66	0.45	0.35	0.55	0.30	0.20	0.40	0.80	0.70	0.90	0.70	0.60	0.80
Netherlands	0.60	0.50	0.70	0.60	0.50	0.70	0.60	0.50	0.70	0.80	0.70	0.90	0.40	0.30	0.50
Poland	0.38	0.28	0.48	0.40	0.30	0.50	0.30	0.20	0.40	0.40	0.30	0.50	0.40	0.30	0.50
Spain	0.48	0.38	0.58	0.40	0.30	0.50	0.30	0.20	0.40	0.80	0.70	0.90	0.40	0.30	0.50
Sweden	0.74	0.64	0.84	0.90	0.80	1.00	0.75	0.65	0.85	0.80	0.70	0.90	0.50	0.40	0.60
Switzerland	0.65	0.55	0.75	0.50	0.40	0.60	0.70	0.60	0.80	0.80	0.70	0.90	0.60	0.50	0.70
UK	0.86	0.76	0.91	0.85	0.75	0.95	0.60	0.50	0.70	1.00	0.90	1.00	1.00	0.90	1.00
USA	0.89	0.79	0.93	1.00	0.90	1.00	0.60	0.50	0.70	1.00	0.90	1.00	0.95	0.85	1.00
Mean	0.60	0.50	0.69	0.63	0.53	0.72	0.50	0.40	0.60	0.71	0.61	0.79	0.59	0.49	0.67

Source: *Janger et al.*, 2013.

4.1.2 Funding context for basic research or research in higher education institutions

Switzerland features the most R&D intensive economy, followed by Austria, Germany and the US, and with some distance by the Netherlands and the UK (Figure 31); the smaller R&D ratio in the latter countries is partly explained by very low shares of manufacturing in the total economy. Basic research is usually only a small share of total R&D, but unfortunately not all OECD countries collect data on the type of R&D, so that we cannot compare countries according to their share of basic research – neither Germany nor the US record basic research.

Figure 31: Gross domestic expenditure on R&D (GERD) as a percentage of GDP, 2000-2016

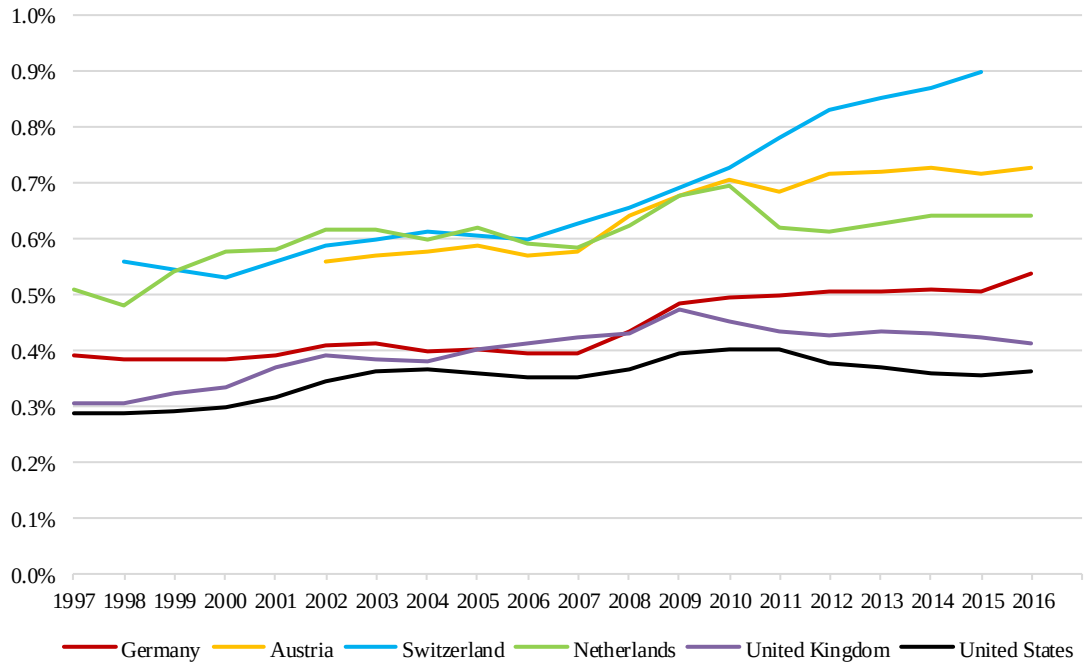


Source: OECD MSTI, variable used "GERD as a percentage of GDP".

As a proxy, we take R&D performed in the higher education sector (HERD, Figure 32). This is not perfect, as there is also applied research in higher education institutions, and there is basic research outside higher education institutions, as in e.g. Germany's Max Planck Society. However, including R&D performed in the government sector (GOVERD) would be too broad, as the bulk of GOVERD is spent in e.g. applied research institutions which usually have very low shares of basic research grant funding. Moreover, as we have seen in section 3, the agencies often also fund applied research, so that the broader HERD category may even be the more suitable reference

category (in Switzerland, 76% of HERD is basic research, in the Netherlands 58% and in the UK 34%). In terms of HERD as a percentage of R&D, Switzerland also leads (by far), followed by Austria, the Netherlands, and then by Germany, the UK and the US. Switzerland has both a strong R&D intensive manufacturing sector and a strong academic research sector. Germany and the US show a comparatively lower share of HERD in GDP as R&D expenditure in the business sector is relatively stronger there. The Netherlands are only weakly specialised in R&D intensive manufacturing, but feature a large higher education sector, so that HERD is comparatively high as a share of GDP. In the UK, industry is not strong either, but R&D in higher education is not higher as resources are heavily concentrated by way of the Research Excellence Framework, the mechanism for allocating block funding in the UK (based on peer review).

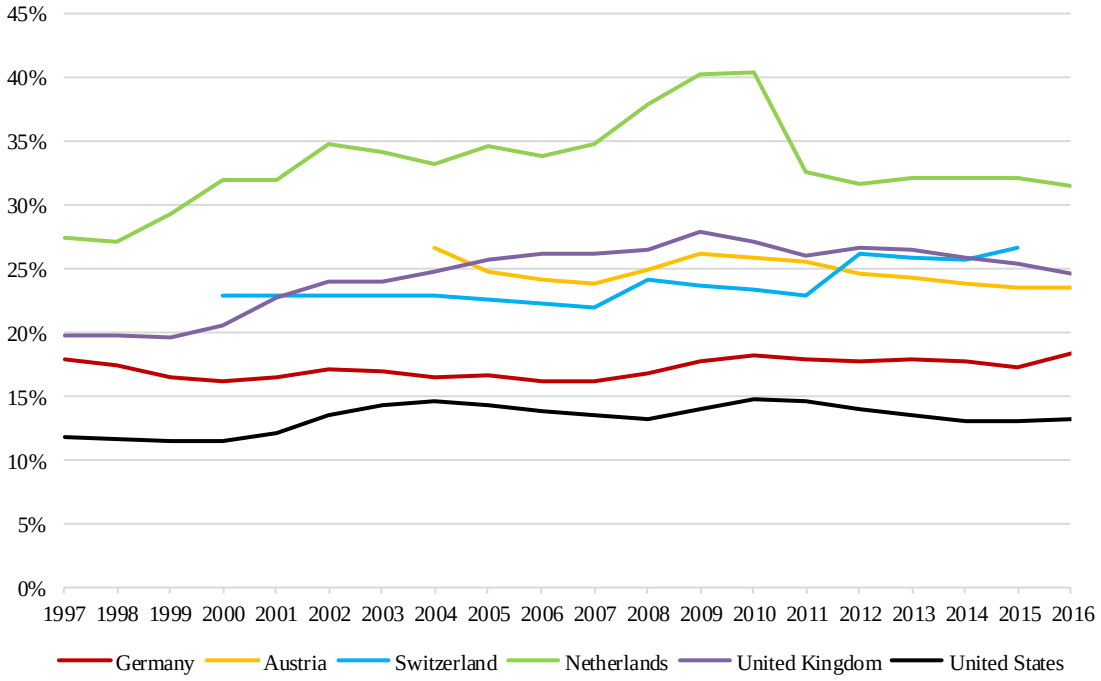
Figure 32: HERD as a percentage of GDP, 1997-2016



Source: OECD MSTI, variable used "HERD as a percentage of GDP".

Figure 33, the share of HERD in GERD (Gross Domestic Expenditure on R&D, i.e. total domestic R&D expenditure), reflects this, with the Netherlands at the top (a strong higher education sector with weak specialisation in R&D heavy manufacturing) followed by the Switzerland, the UK and Austria, with Germany and the US at the bottom.

Figure 33: Share of HERD in GERD (total R&D expenditure), 1997-2016



Source: OECD MSTI, variables used "Gross Domestic Expenditure on R&D -- GERD (current PPP $)", "Higher Education Expenditure on R&D -- HERD (current PPP $)".

Table 32 shows the various funding sources of HERD in the countries based on OECD data, to which we merged the yearly amount of funds allocated by the research grant funding organisations (bottom line); this should be similar to the "direct government" position. Again, this can only provide a rough picture of the importance of the agencies for HERD, as they do not only fund higher education institutions and as there may be classification issues in terms of whether all of the money allocated by the agencies is purely R&D according to the OECD's Frascati Manual (e.g., funding for career development may not be counted as R&D).

The four continental European countries show clearly higher funding of HERD by public sources, between 81-88%, whereas the two Anglo-Saxon countries are lower at roughly two thirds of total HERD. The difference is not accounted for by business enterprise funding of HERD – on the contrary, the four continental countries' HE research systems are as much funded by business as the two Anglo-Saxon countries, Germany even higher. This is a development of the past 20 years. At the beginning, the UK and US had higher business funding shares of HERD, but these shares have declined, whereas the shares in Austria, Switzerland, Germany and the Netherlands have increased. This belies the often heard complaint about a lack of cooperation between academic and business research in Europe. In the past 20 years, many European countries specifically launched funding schemes for R&D collaboration between academic and corporate researchers (although often not within basic research grant funding organisations). Firms in the US fund less research in higher education institutions partly because of the developments in the wake of the Bayh-Dole act, i.e. universities becoming more aggressive towards making money out of their research.

Within government funding, there are two sources (not always detailed in the OECD data), direct government (which includes the basic research agencies) and general university funds (GUF), the block funding given to universities. To determine the impact of competitive incentives set by grant funding, it is necessary to know how the block funding is allocated, on a performance basis (e.g. using output indicators or peer review) or without, which will influence the amount of incentives set by the block funding. *Zacharewicz et al.* (2018) have recently classified the block funding systems of the EU countries including Switzerland, providing up to date information. Switzerland has a high share of GUF and is classified as not featuring a performance-based ex-post funding system, only with respect to education are there output-oriented metrics. The Swiss system features cantonal (state-level) universities and federal universities (ETH and EPFL), with corresponding funding sources. Even though there are

no strict performance-based measures however, the Swiss coordination framework for higher education stresses the importance of competition between universities[9].

Germany's universities are financed by its Länder (states), and although the mechanisms for funding differ, Germany is classified by *Zacharewicz et al., 2018*, as having only a limited research performance based funding model, just like the Netherlands and Austria. The UK, by contrast, features a strong peer-review based allocation model of block funding, so that nearly all of the public funding coming into British universities is peer reviewed, either ex-post or ex-ante. The US, finally, does not have block funding at all, as education is paid by tuition fees and research funded by grants from government, among others, so that the US and the UK achieve by far the highest share of research funding based on competitive allocation mechanisms. Next to the NIH and NSF covered in this study, (academic) research is also funded by the Department of Defense and the Department of Energy, as well as by the Department of Agriculture and NASA (see *Stephan, 2012*, for an overview).

Other noteworthy differences between the countries include funding by higher education itself, which is particularly high in the US and may reflect the importance of endowments and of high tuition fees which may be used on occasion to fund research (*Ehrenberg - Rizzo - Jakubson*, 2003). Private non-profit funding is highest in the two Anglo-Saxon countries and interestingly by far in the UK rather than in the US. Funds from abroad are highest in the UK, which may be partly linked to success in obtaining EU research funding. The evolution of the share of funding sources of HERD over time is provided in the annex (section 8.2).

Table 32: Funding sources of HERD across countries, data based on conversion in USD PPP, last available year

	DE	AT	CH	NL	UK	US	Average
Total (funding sector)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Business enterprise	14%	5%	10%	8%	4%	5%	8%
change to first year available	*+4*	*+4*	*+3*	*+2*	*-1*	*-2*	*+2*
Sub-total government	81%	88%	81%	77%	62%	58%	75%
change to first year available	*-7*	*-7*	*+0.4*	*-9*	*-5*	*-7*	*-6*
Direct government	N/A	22%	16%	N/A	33%	58%	32%
change to first year available	*N/A*	*+8*	*-0.3*	*N/A*	*+1*	*-7*	*+0*
General university funds	N/A	65%	64%	N/A	30%	0%	40%
change to first year available	*N/A*	*-15*	*+1*	*N/A*	*-6*	*N/A*	*-7*
Higher education	N/A	N/A	4%	0%	4%	26%	8%
change to first year available	*N/A*	*N/A*	*-5*	*+0*	*-0.3*	*+6*	*+0*
Private non-profit	N/A	1%	0.1%	7%	14%	9%	6%
change to first year available	*N/A*	*+1*	*-4*	*+2*	*-2*	*+1*	*-0*
Funds from abroad	5%	6%	5%	8%	16%	2%	7%
change to first year available	*+3*	*+3*	*N/A*	*+5*	*+8*	*+2*	*+4*
Funds of agencies	18%	8%	15%	20%	30%	46%	23%
change to first year available	*+5*	*+2*	*+1*	*+9*	*+10*	*-9*	*+3*

Source: OECD R&D statistics, fund data (converted into US PPP), WIFO calculation For AT data: http://www.statistik.at/web_en/statistics/EnergyEnvironmentInnovationMobility/research_and_development_r_d_innovation/r_d_in_all_economic_sectors/index.html, Table "Higher education sector: Financing of expenditures on research and experimental development (R&D) 2015 by fields of science and sources of funds". Note: Last available year: CH, DE = 2014; AT, NL, UK, US = 2015. Change to first year available: DE =1997, AT, CH = 1998, US = 1999, UK = 2002, NL = 2003. Due to missing data, figures for Austria of the subcategories Direct Government and General university funds were updated to the same extent as in 2013.

4.1.3 Differences in mission & structure of grant funding agencies

Differences in mission and organisational structures of the grant funding organisations may influence the funding portfolios, e.g. a focus on research would lead to a lower share of thematic and translational funding schemes. Table 33 shows that most agencies tick all boxes from research to impact, but this rough assessment masks the different intensities with which the agencies stress particular parts of their mission, e.g. use of research or economic impact is much less focused on in the mission statement by the DFG than in the mission statement by the NIH and the UK Research Councils or the Netherlands, which also shows up in the different shares of funding schemes in the total portfolio, or in the thematic focus or definition of research questions (section 4.3).

[9] https://ec.europa.eu/education/compendium/federal-act-funding-and-coordination-swiss-higher-education-sector-heda_en .

Table 33: Mission or activity focus of the agencies, 2017

Country	**DE**	**AT**	**CH**	**NL**	**UK**	**US**	
Agency	*DFG*	*FWF*	*SNSF*	*NWO*		*NIH*	*NSF*
Funding basic research	x	x	x	x	x	x	x
Fostering dissemination of knowledge, use of research results	x	(x)	x	x	x	x	
Creating economic and societal impacts		(x)	x	x	x	x	x
Education and career development	x	x	x	x	x	x	x

Source: Assessment by WIFO of self-declared mission statements by basic research grant funding organisations. UK refers to the 7 Research Councils.

Differences in mission and focus may also be linked to the overarching decision structures and the role of the scientific community within them (Table 34). In agencies characterised by academic self-governance, or a larger role of the scientific community in overall decision-making and strategy setting, more focus may be put on the advancement of science, rather than on delivering impact or solutions to applied problems. In Germany, Austria and Switzerland, there is a requirement that the academic community is represented in a balanced way in the statutory bodies of the agencies. This needs however a more detailed investigation than was possible within the scope of the present study.

Table 34: Overarching decision making

Country	**DE**	**AT**	**CH**	**NL**	**UK**	**US**	
Agency	*DFG*	*FWF*	*SNSF*	*NWO*		*NIH*	*NSF*
Academic self-governance	x	x	x				
Governmental agency				x	x	x	x

Source: Assessment by WIFO based on description of organisational structures by agencies. UK refers to the seven Research Councils.

The budget approval process for the agencies can influence the long-term perspective for researchers' funding opportunities, as well as the ease of securing budget increases (Table 35). There are several models, with funding directly approved by the legislative (Congress) in the US, whereas in other countries, the budgets of the agencies are a part of the budget of the corresponding Ministry (mostly the ministries for science and education, however in the UK it is the Department for Business, Energy and Industrial Strategy: there is not even a ministerial department carrying the name "science" or "research" in it, which may also contribute to explaining the strong focus on impact in the Research Councils' mission statements). In Germany, the budget of the DFG needs approval from both federal and Länder executives; the current DFG's budget increases are anchored in a longer-term strategy by the German government ("Pact for Research and Innovation 2016-2020") but unlike the SNSF, the DFG nor any other agency feature a multi-year financial framework.

Table 35: Budget approval process, 2017

Country	**DE**	**AT**	**CH**	**NL**	**UK**	**US**	
Agency	*DFG*	*FWF*	*SNSF*	*NWO*		*NIH*	*NSF*
Budget directly approved by legislative						x	x
Budget is part of the responsible government departments/ ministries' budgets	x	x	x	x	x		
Budget depends on federal-state level coordination	x						
Multi-year financial framework	(x)		x				

Source: Assessment by WIFO based on information provided by agencies. UK refers to the seven Research Councils. Note: NIH has a five-year strategic plan, but budget appropriation is yearly.

Finally, the organisation of funding activities may affect the potential for experimentation and the diversity of funding schemes, as well as the ease of use for applying researchers (Table 36). The issue of discipline-specific vs. non-discipline specific funding has already been discussed in section 2. On paper, the Austrian, Swiss, Dutch

and German agencies are quite similar in that they use non-discipline specific funding schemes; however, in the Dutch case, these are cross-cutting instruments which will then be used by specific, discipline-oriented NWO divisions, more similar actually to the NSF which also uses common instruments for a variety of disciplines (but is organised according to thematic research areas). The UK Research Councils have recently been merged into one agency, UKRI, and it remains to be seen whether their funding instruments will be more harmonised as a result. Many Research Councils do have similar funding schemes though and there are agreements between the Councils to safeguard the possibility of interdisciplinary funding.

It is clear that smaller countries such as Switzerland will tend to have more centralised research funding organisations than large countries such as the US. For researchers, simple structures such as the SNSF and the DFG may be easier to use from an administrative viewpoint (i.e., finding the right funding opportunity). The funding activities of the NIH or the NSF are by comparison much more complex (see section 3, with the multitude of NIH activity codes and NSF funding opportunities).

Table 36: Organisation of funding activities, 2017

Country	**DE**	**AT**	**CH**	**NL**	**UK**	**US**	
Agency	*DFG*	*FWF*	*SNSF*	*NWO*		*NIH*	*NSF*
Centralised non-discipline specific funding schemes	x	x	x	(x)			
Centralised discipline-specific funding schemes							x
Decentralised discipline-specific funding based on common instruments						x	
Decentralised discipline-specific funding without common instruments					x		

Source: Assessment by WIFO based on description of funding activities by agencies. UK refers to the seven Research Councils.

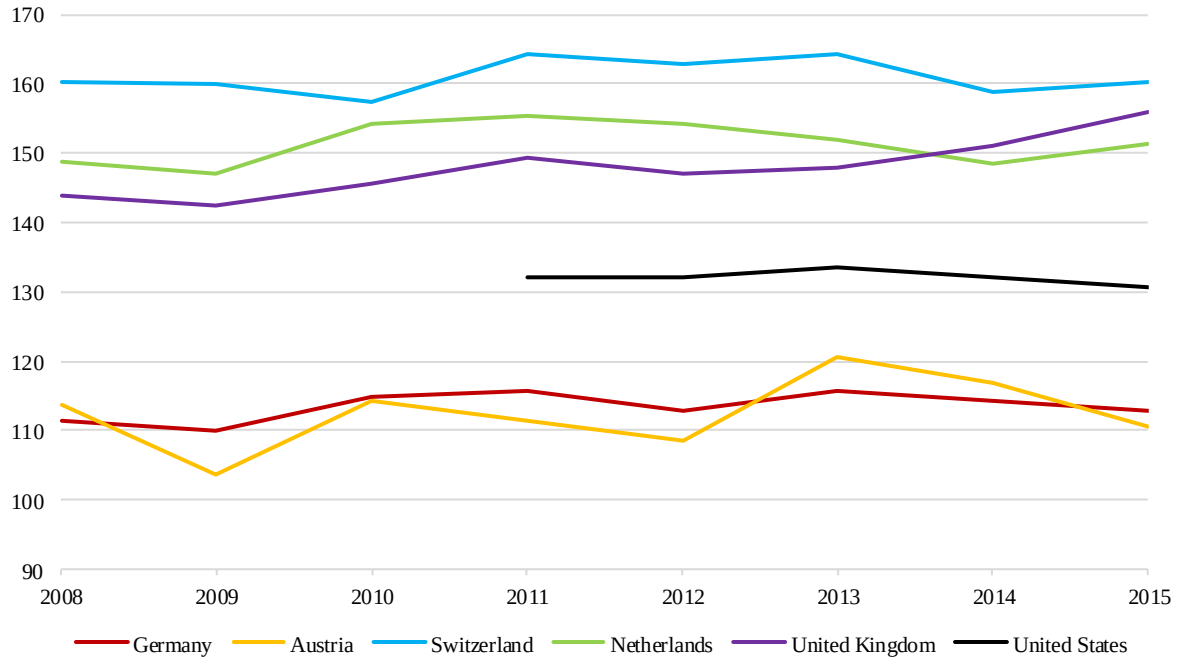
4.1.4 Performance of science systems

The overall "performance" of science systems can be measured in various ways, here we provide just a rough overview based on citation frequency, in three different indicators – the share of articles in the top 10% cited articles of each field by country, as taken from the European Innovation Scoreboard (Figure 34); the number of highly cited scientists in each country (Figure 35 and Figure 36); the number and share of universities by rank group in the Leiden ranking which is purely based on citations (Figure 37, Figure 38 and Table 37); and the number of ERC grants per 1.000 researchers (Figure 35). Such performance measurements are of course subject to debate, but it is outside the scope of this study to elaborate further on them.

In a nutshell, in terms of absolute numbers, by far the greatest concentration of universities achieving a high share of highly cited publications and of highly cited scientists is located in the US, followed by the UK (Figure 35, Figure 37 and Table 37). Relative to population (Figure 36 and Figure 38) and in terms of the share of all publications (Figure 34), Switzerland achieves the highest performance. E.g., although it has only two universities in the top group (1-50), this small number is very high considering Switzerland's small population of about 7 million (Figure 38); in addition, the top rank group gets a higher weight, in accordance with a methodology developed by *Aghion et al., 2010*. Regarding universities' ranking relative to population (Figure 38), the Netherlands comes second, as it features several universities in the 51-100 rank group, far more than Germany (which does not have any universities in this rank group).[10] However, regarding highly cited scientists, the Netherlands comes last, with the UK and the US behind Switzerland (Figure 36). This is partly explained by Germany's Max Planck Society, which is not included in this university ranking, but features a relatively high number of highly cited scientists.

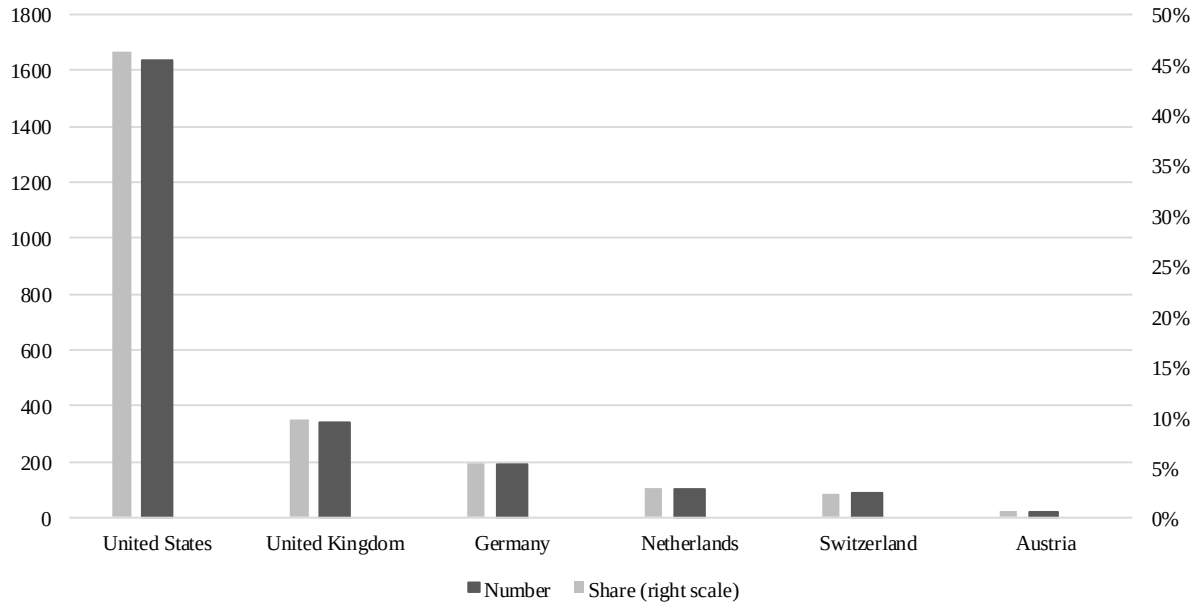
[10] The CWTS Leiden Ranking is different to other rankings such as the Shanghai or the THES Ranking which use statistical and survey data to establish university rankings. The CWTS Leiden Ranking is purely based on bibliometric data, on the share of highly cited articles in the total number of publications of a university. By using this share, it automatically also controls for university size. To gain a picture of research performance, the CWTS Leiden Ranking may hence be seen as more accurate than Shanghai or THES, however it does not assess teaching, which in our case is not a problem.

Figure 34: Scientific publications among the top 10% most cited publications worldwide as % of all scientific publications in a country (EU-28 in year 2010 = 100), 2008-2015



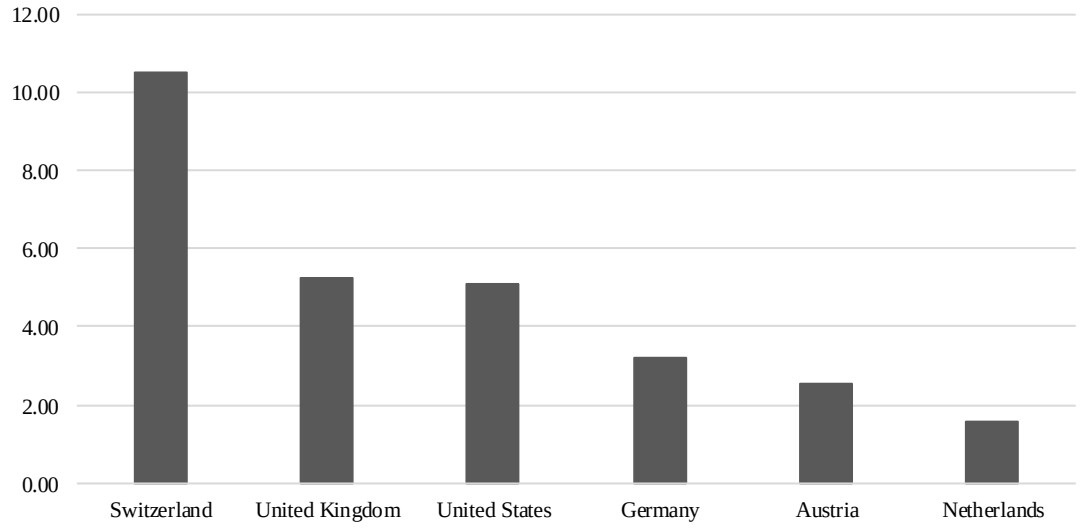
Source: European Innovation Scoreboard 2018, Indicator 1.2.2. All study countries are above the EU average. The figure compares the share of all highly cited publications in a country to the EU average, where highly cited is defined as among the top 10% most cited worldwide.

Figure 35: Number of highly cited researchers per country (left-hand scale) and share of all highly cited researchers (right-hand scale), 2017



Source: Highly cited researchers by Clarivate Analytics, WIFO calculation.

Figure 36: Number of highly cited scientists relative to population, 2017



Source: Clarivate Analytics.

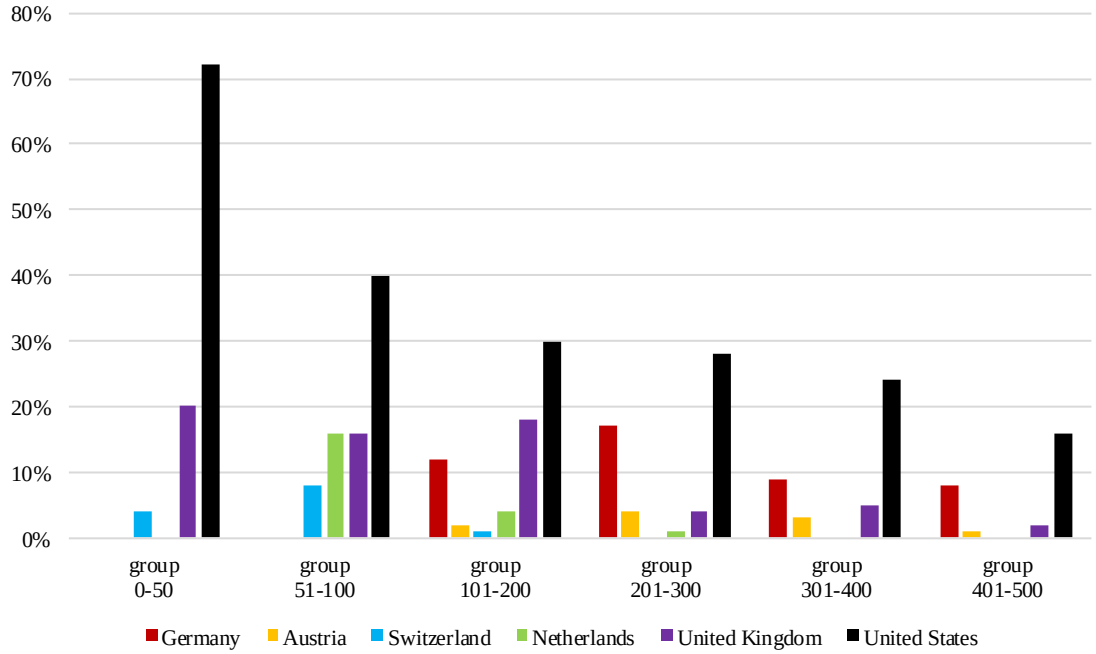
The concentration of universities and highly cited researchers in just five (without Austria) countries is astonishing – 96% of the top 1-50 and 80% in the group 51-100, as well as two thirds in the group 101-200 come from the five countries, with the US and the UK featuring the highest shares in the top 100. Two thirds of all highly cited researchers are also located in these five countries. In terms of performance, we note that both countries with very high shares of competitive grant/block funding (US and UK) do well, just as countries with a much lower share of competitive funding in total HERD (Switzerland), albeit with very high competitive funding relative to population as we will see in the next section (i.e., Switzerland's SNSF share in total research funding is not that high, but in absolute terms, it provides a lot of funding, indicating that Swiss universities have ample research funding). Countries with very low levels of competitive research funding (Austria) do much worse with respect to scientific performance, relative to population in particular with regard to the other smaller European countries.

Table 37: Country share of universities in Leiden Ranking 2017 by rank groups

	group 0-50	*Change 2015-2009 in ppt*	**group 51-100**	*Change 2015-2009 in ppt*	**group 101-200**	*Change 2015-2009 in ppt*	**group 201-300**	*Change 2015-2009 in ppt*	**group 301-400**	*Change 2015-2009 in ppt*	**group 401-500**	*Change 2015-2009 in ppt*
Austria	0%	*0*	0%	*0*	2%	*-1*	4%	*+1*	3%	*0*	1%	*0*
Germany	0%	*0*	0%	*+2*	12%	*0*	17%	*+3*	9%	*-1*	8%	*-1*
Netherlands	0%	*0*	16%	*-2*	4%	*0*	1%	*0*	0%	*0*	0%	*+1*
Switzerland	4%	*0*	8%	*-2*	1%	*+1*	0%	*0*	0%	*0*	0%	*0*
United Kingdom	20%	*-10*	16%	*+2*	18%	*+4*	4%	*+2*	5%	*-2*	2%	*0*
United States	72%	*+12*	40%	*+6*	30%	*+2*	28%	*+3*	24%	*-3*	16%	*-2*

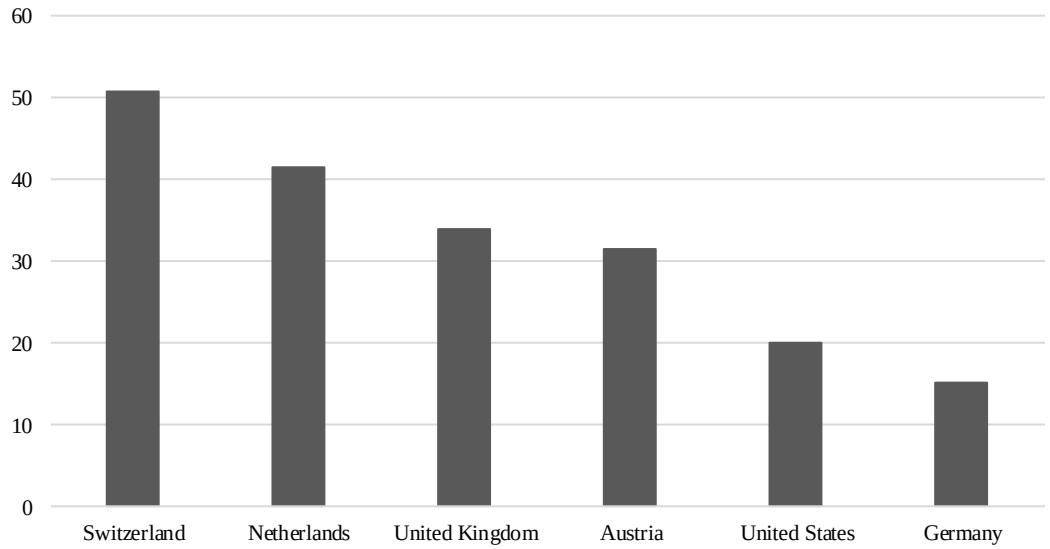
Source: CWTS Leiden Ranking, http://www.leidenranking.com/, WIFO calculation.

Figure 37: Country share of universities in Leiden Ranking 2017 by rank groups



Source: CWTS Leiden Ranking, http://www.leidenranking.com/, WIFO calculation.

Figure 38: Leiden-ranking indicator (relative to population), 2017



Source: CWTS Leiden Ranking, calculated by WIFO. Note: Number of universities in each rank group of Leidenranking were weighted with population. Methodological note: We use the indicator in the CWTS Leiden Ranking of the share of articles a university has placed among the top 10% cited articles in a field. We sum the resulting measure by rank group (1-50, 51-100, etc.) and attach weights to the different ranking groups before we relate the resulting number to the number of higher education researchers in full time equivalents as measured by the OECD to control for country size.

The number of ERC grants per 1.000 higher education researchers shows a similar picture as the university indicator which controls for size, in that Switzerland and the Netherland show the highest number of grants. However, the UK achieves a lower number here, presumably due to its large higher education sector.

Figure 39: ERC grants per 1000 Higher Education researchers, 2009-2017

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Germany	0.71	1.47	1.43	1.48	1.64	2.09	1.79	2.11	2.22
Austria	1.24	1.86	2.31	1.33	2.22	2.04	2.84	3.20	2.66
Switzerland	3.40	3.15	3.02	4.30	4.82	1.73	5.27	5.52	4.95
Netherlands	1.78	2.19	4.22	4.17	4.73	5.24	5.24	5.04	4.83
United Kingdom	0.68	0.84	1.27	1.51	1.27	1.36	1.47	1.25	1.45

Source: ERC website, OECD MSTI database for Higher Education Researchers FTE. Note: Number of grants is calculated as the sum of starting/advanced and consolidator grants per country.

4.2 Funding at aggregate level

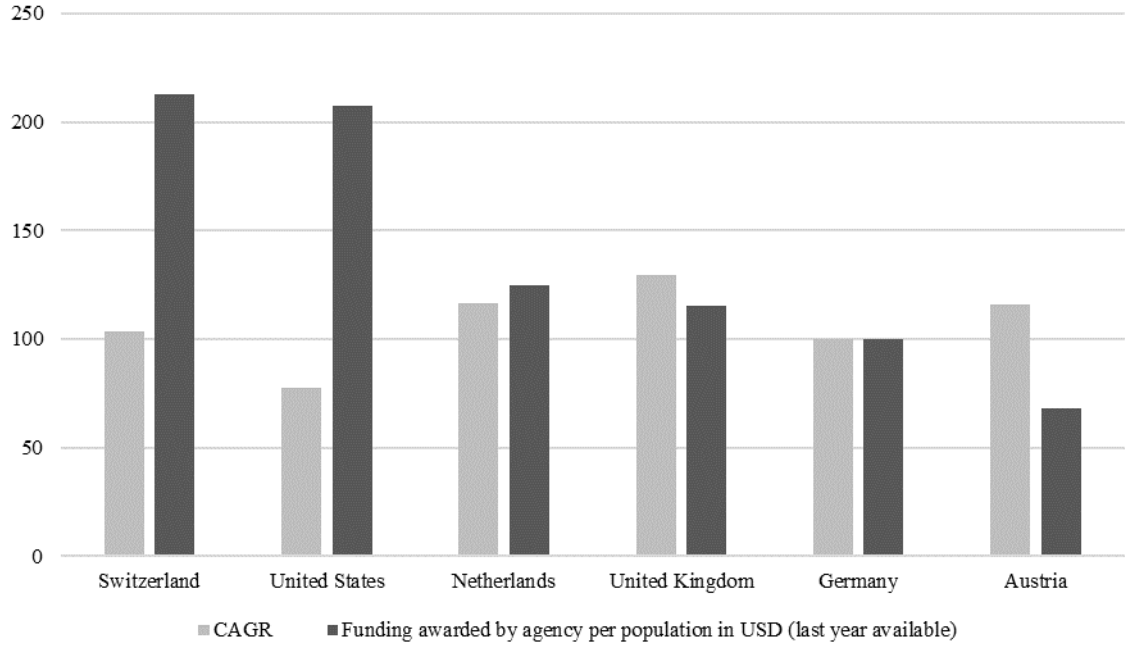
In the next Table 38 and Figure 40, we compare the growth and levels of overall funding relative to population (relative to the number of researchers in the higher education sector is more appropriate, but there are no data for the US; we show these data below for the countries except for the US). Switzerland shows the highest funding levels per capita, followed by the US; all the other countries are far behind, with Austria at the bottom. Germany is in fifth place, just behind the UK. This is somehow puzzling, as we have seen in section 4.1.2 that the share of the SNSF in total HERD was not that big, whereas the US share (NSF and NIH) was much higher. There may be an underrepresentation of US higher education research in OECD data, due to cross-subsidising from tuition fees (see *Ehrenberg - Rizzo - Jakubson*, 2003). Average growth rates are much more similar, clearly above inflation rates, so that all countries have seen real increases in grant funding of basic research (although costs of research probably rise faster than on average in the economy, so that the true real increase may be lower, and not that much at all in the US, which shows the lowest growth rate in spite of the doubling of the NIH budget at the beginning of the time period). Germany achieves the second-lowest growth rate.

Table 38: Cumulative average growth rate (CAGR) of total funding awarded (in national, nominal currency) and funding awarded by agencies per population, in USD PPP

Country	Agency	Last/First year available	CAGR	Funding awarded by agency per population in USD (first year available)	Funding awarded by agency per population in USD (last year available)
Germany	DFG	2016-1997	5.8%	13	47
Austria	FWF	2017-1997	6.8%	8	32
Switzerland	SNSF	2017-1997	6.0%	24	101
Netherlands	NWO	2016-2000	6.8%	20	59
United Kingdom		2016-2002*	7.6%	22	55
United States	NIH&NSF	2017-1998	4.5%	50	98

Source: Annual Reports of agencies, OECD MSTI, WIFO calculation. Note: UK: all research councils, *ESRC Budget only available since 2011. Other Research Councils have also been interpolated for missing sums, so that the table needs to be interpreted with care.

Figure 40: Cumulative Average Growth Rate (CAGR) and funding awarded by agencies per population on index basis, DE = 100.



Source: Annual Reports of agencies, OECD MSTI variable used "Population", WIFO calculation. Note: Last year available: AT, US, CH=2017; DE, NL, UK=2016.

Relative to the number of HER (Table 39, Figure 41, Figure 42), the Netherlands is leading, ahead of Germany, Switzerland and the UK. Note that researchers in extra-university research institutions such as Max Planck Institutes are not included, however. In terms of growth we look this time not at the growth of total funding but at growth of funding per HER. Growth rates are lower by comparison with total funding growth, indicating growth of the number of HER. The Netherlands lead ahead of the UK and Germany. As we use nominal data, values below approx. 2% indicate a real reduction in the amount of funding awarded relative to the number of HER.

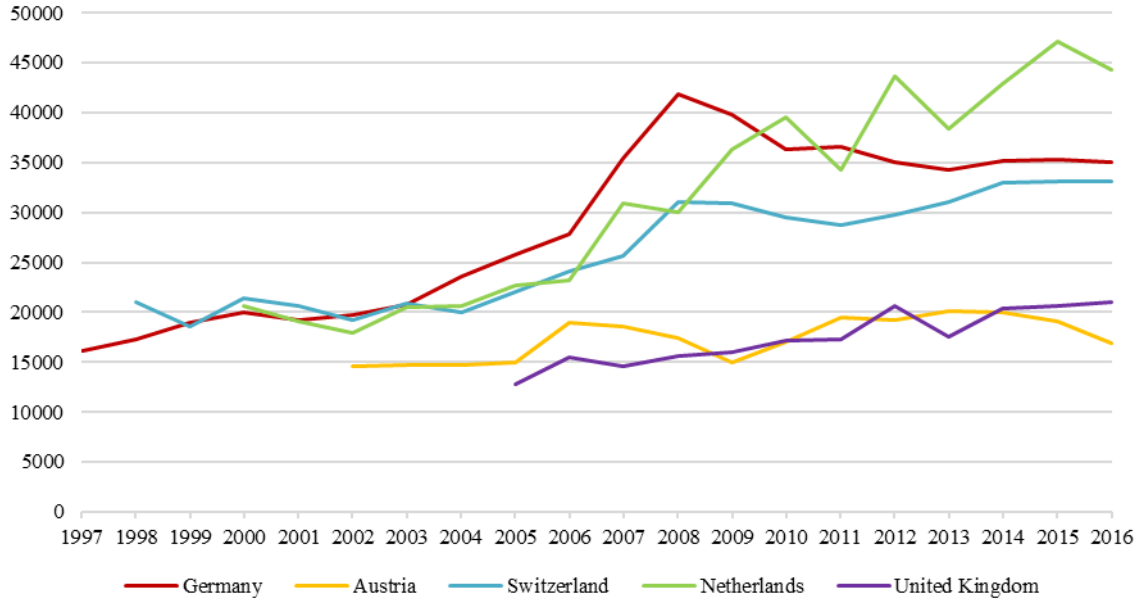
Table 39: CAGR and level of funds awarded per HER by agencies, in USD PPP

Country	Agency	Last/First year available	CAGR	Funding awarded by agency per HER in USD (first year available)	Funding awarded by agency per HER in USD (last year available)
Germany	DFG	2016-1997	4.2%	16157	35088
Netherlands	NWO	2016-2000	4.9%	20605	44336
Austria	FWF	2016-1998	1.7%	12446	16965
Switzerland	SNSF	2016-1998	2.6%	21040	33112
United Kingdom		2016-2005*	4.7%	12740	21048

Source: Annual Reports of agencies, OECD MSTI variable used "Higher Education researchers (FTE)", WIFO calculation. Note: UK: all research councils, * ESRC funding only available since 2011. Other Research Councils have also been interpolated for missing sums, so that table needs to be interpreted with care.

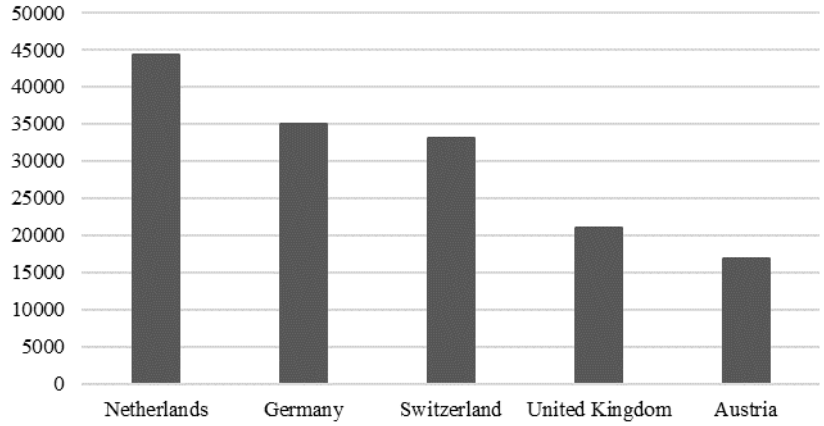
Over time, most agencies show low growth since the financial crisis in 2008.

Figure 41: Total yearly funding by basic research agencies relative to Higher Education Researchers (FTE), in USD per HER, 1997-2016



Source: Annual reports of agencies, OECD MSTI variable used "Higher Education researchers (FTE)", WIFO calculation. Note: UK: all research councils, * ESRC funding only available since 2011. Other Research Councils have also been interpolated for missing sums, so that figure needs to be interpreted with care.

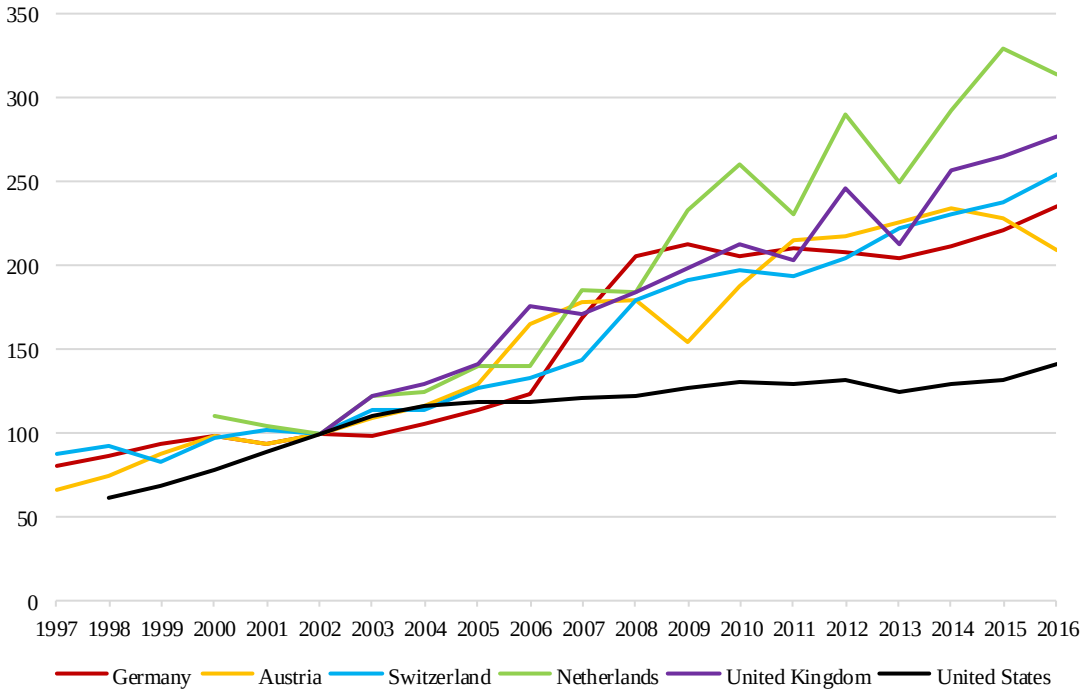
Figure 42: Total funding by basic research agencies relative to Higher Education Researchers (FTE), in USD per HER, 2016



Source: Annual reports of agencies, OECD MSTI variable used "Higher Education researchers (FTE)", WIFO calculation.

The varying dynamics of the funding allocated by the agencies is clearly visible in Figure 43, where the US shows stronger increases at the beginning, but then stays relatively flat, leading to many problems in the US (see section 2 on hypercompetition in the biomedical research enterprise).

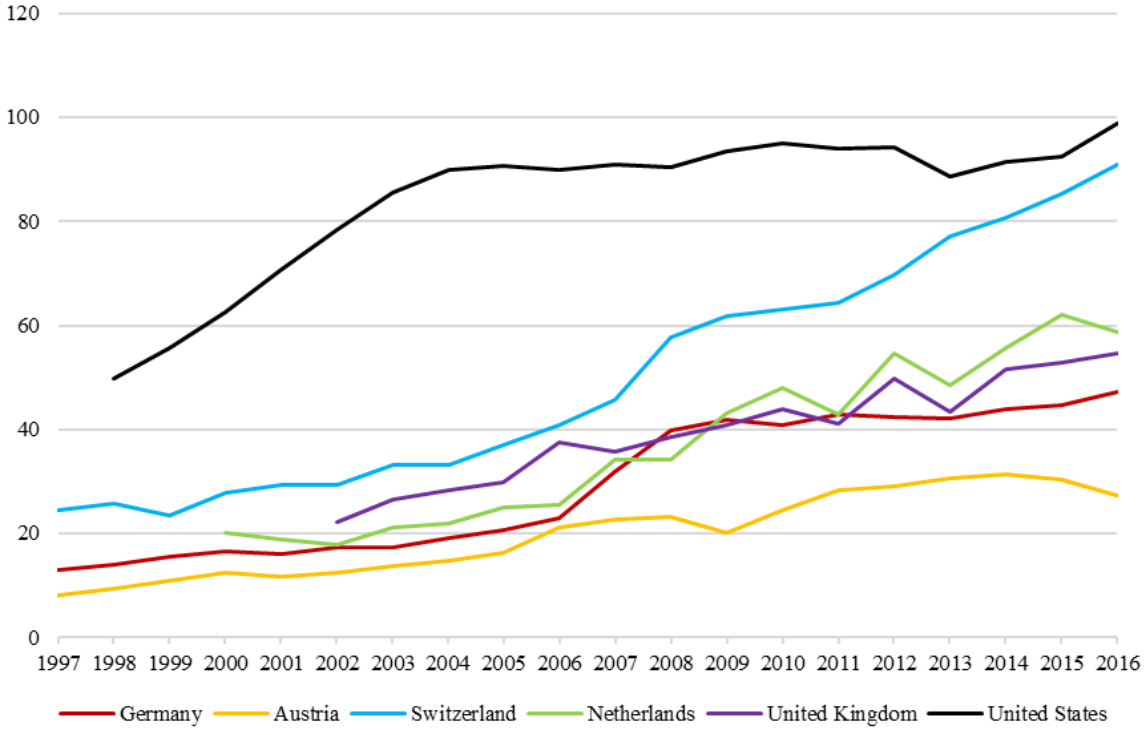
Figure 43: Total yearly funding by basic research agencies on an index basis, 2002=100, 1997-2016



Source: Annual Reports of agencies, WIFO calculation.

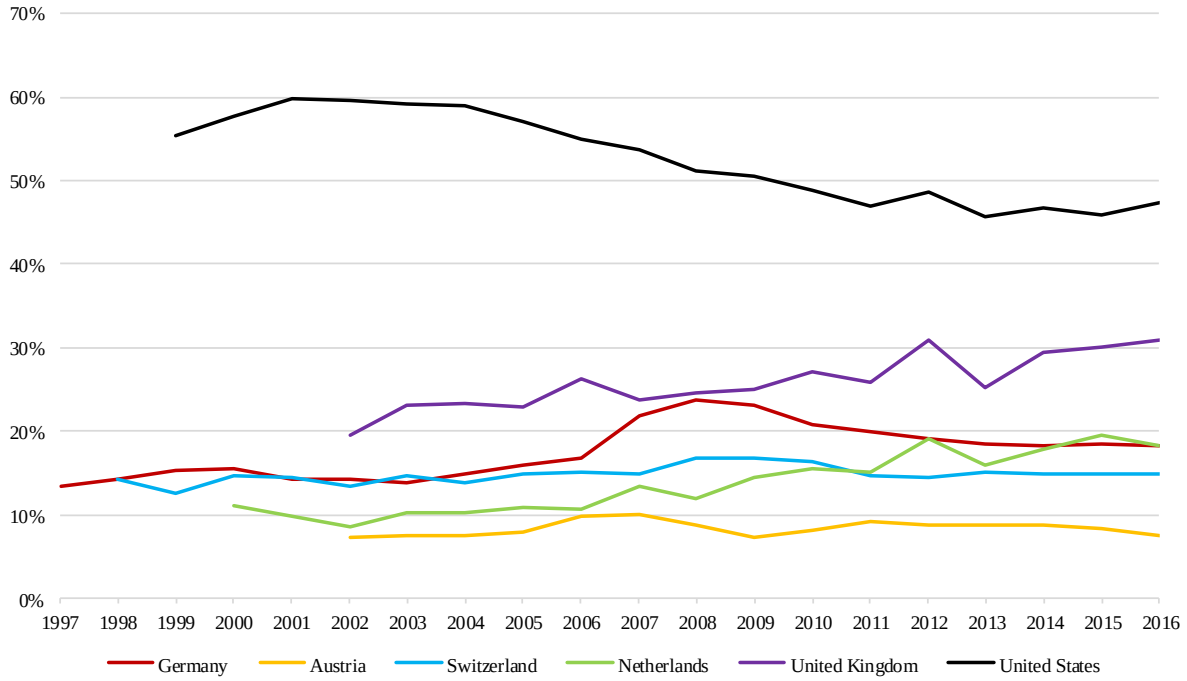
Figure 44 shows funding relative to population over time, Figure 45 the share of agency funding in HERD over time, with Austria always at the bottom.

Figure 44: Total yearly funding by basic research agencies relative to population, in PPP USD per population, 1997-2016



Source: Annual Reports of agencies, OECD-MSTI variable used "Population", WIFO calculation.

Figure 45: Total yearly funding by basic research grant funding agencies as a share of HERD, 1997-2016



Source: Annual Reports of agencies, OECD MSTI variable used "HERD in national currency (for euro area: pre-EMU euro or EUR), WIFO calculation.

4.3 Differences in funding portfolios (what or who gets funded)

In this section, we move from the aggregate level to the individual funding schemes, first pointing out differences in funding portfolio by the shares of funding schemes classified by broad types as explained in section 3.

Before interpreting the figures, we recall that the basic research grant funding organisations are part of different research funding landscapes, so that a higher or lower diversity in funding portfolios may partly be related to different assignments of tasks in national research systems. As an example, translation programmes may also be funded by innovation or applied research funding agencies (as an example, the EPSRC funds R&D collaboration programmes with firms, while in Germany the Federal Ministry for Economic Affairs and Energy funds more innovation-oriented research activities by firms); and overall budget size also influences funding diversity, i.e. an agency with a comparatively smaller budget (controlling for size) should in principle focus on fewer programmes.

Furthermore, the data in particular for the Netherlands and the UK, but also the NSF (for funding scheme detail, not for funding by discipline) need to be interpreted with caution, as the financial information reported in the yearly reports or on the website does not fully match the description of funding activities (the funding opportunities available for researchers) on the websites of the agencies. Note that a "-" sign means that the scheme does not exist, and that an "N/A" sign indicates that the scheme exists in principle, but that no data are available (at the broad programme type level, data are more often available than for individual funding schemes). The "N/A" sign concerns mostly the Netherlands and the UK. Also note that we looked only at NIH funding schemes above a minimum size threshold, except for Common Fund schemes aiming at high-risk, early career and interdisciplinary research, so that we miss some smaller initiatives.

Finally, the shares of funding schemes also need to be interpreted bearing in mind the flexibility of the funding schemes, e.g. in Germany, the standard single project funding scheme features specific assessment criteria for first-time applicants, while Switzerland has got specific funding schemes for first-time applicants (or early career principal investigators); in Switzerland, proposals within the main project funding scheme can self-declare to be use-inspired, so that it is not strictly pure basic research. In the UK, interdisciplinary projects, networks and R&D collaboration can also be filed within the standard research grants funding scheme. For the UK, it is hence safer to only assess the broad type "project funding" rather than going into the sub-categories of project funding. In the Netherlands, the talent programme could also be classified as an SPF early career funding scheme, so that project funding would not lose as much in terms of the share of total funding awarded. Thematic focus is also misleadingly

low, as the NSF, the NIH, the UK Research Councils and NWO use their standard research grants and other mechanisms to fund discipline-oriented or thematic-focus calls, which are often not reflected in financial information provided on their funding portfolios.

Table 40 shows that research project funding takes the largest share in most of the agencies' total yearly funding (from about close to 50% upwards, except for Germany at 37%) and within project funding the standard funding of individual principal-investigator based project funding (from about 30% of total funding upwards). Exceptions to this are the Netherlands' open competition programme, which decreased from 40 to 10% at the benefit of infrastructure and translational spending (no details can be given as to the precise programme, because of the difficulties mentioned); and the UK's ESRC (again, the UK needs to be interpreted with caution). Taking account of the variation in single project funding schemes (see also next section), Switzerland has the highest share of curiosity-driven, bottom-up grant funding (almost 50% of total), while Germany is at about 30% and Austria at 43%; the schemes of the other agencies often accommodate a wider range of proposal types or feature strong criteria for economic or societal impact (see next section), or also include some solicited research, as the R01 grants by the NIH, which achieves 45% of total NIH funding.

Other funding schemes within project funding comprise mostly specific high-risk or early career funding schemes; where we got data, they are however small by comparison with the main single project funding grant types (note that early career researchers can also be handled through specific review criteria in the main single project funding scheme, as in Germany). The SNSF, and in particular the DFG and the NIH also feature network- or multi-project funding schemes. Interdisciplinary project funding is rare in terms of dedicated schemes, it is important only in the UK AHRC and occupies a small share in the NIH and NSF project funding. However, many agencies accept interdisciplinary proposals within their standard research grant schemes, including the UK Research Councils and Switzerland. Moreover, many of the networks & multi-project funding scheme also have interdisciplinary research objectives. Judging by the share of interdisciplinary research in the split by disciplines (see below), interdisciplinary research would nevertheless remain at a low level.

In terms of dynamics, in many agencies, the standard single project funding is slightly declining, with increases mostly in other broad programme types such as infrastructure and translation (not for the DFG though); although the DFG also increases the relative share of infrastructure spending, the highest increase can be seen in the structural priority area due to the excellence initiative. Austria has increased most education&training as well as international cooperation.

Behind project funding, there is more heterogeneity in funding portfolios, with agencies differing in which funding scheme type takes the highest share. For some it is funding of people (for NWO and ESRC it is the highest category overall, at SNSF and FWF it comes second), for others structural priority areas (as for the DFG, e.g. due to its "excellence initiative", and NERC, ESRC), for others infrastructure (NSF) and translation (NWO, NIH).

Within the funding of people schemes, the largest share is either taken by career-supporting funding schemes (from about 3 to 19% of total funding), or by education and training (FWF, NSF, the DFG and the ESRC), , e.g. as a consequence of funding PhD-training graduate schools; the NSF is also active at supporting interest in or teaching of science before university starts. Mobility, prizes and diversification schemes usually take a much lower share in total funding. Note that funding of people is also possible in standard research grant schemes, or an explicit objective in some network and multi-project schemes, as in Germany.

In terms of priority programmes, these are mostly of a structural nature, i.e. aimed at enhancing "excellence" or visibility of research, and less so focusing on a thematic priority (except for the SNSF and some UK councils). Note though that most of UK councils and the NSF and NIH don't have thematic priority funding, but that these are operating on a discipline-specific basis and are using their standard research grants in many thematic calls. Both the UK and NIH/NSF agencies have in addition solicited research among the single project funding (see section 4.4). NWO also explicitly has a sectoral focus with the Dutch "Top Sectors"-policy, where it is charged with coordinating the basic research-based input. Top sectors is a cross-cutting scheme however and is not being shown separately in terms of funds involved. Thematic focus of the agencies is hence probably most underrepresented in this analysis of funding portfolios; we provide much more detail in the next section on grant design.

Spending on infrastructure increases in all agencies (except for the FWF, where such a scheme does not exist), but varies widely from 4-5% in the SNSF and the NIH to 24% in the NSF, with the DFG at the lower end with around 7%. Many agencies also have some form of translational funding scheme, although the importance in overall

funding varies considerably from close to 20% in NWO or STFC, above 10% in the NIH and lower shares at about 5% in the SNSF and 3% at the NSF, while it is minor in Germany or Austria. The schemes are very different though, from the SBIR programme at NSF (supporting innovation in small young businesses), to funding clinical studies in medicine or commercialisation activities in universities. NIH also has an initiative whereby it funds everything, from basic research to applied research and commercialisation/development of applications ("R&D value chain"), effectively spanning the roles of basic research and innovation agency which is also a rationale behind the merging of the UK Research Councils with Innovate UK under the umbrella of UKRI and the reforms of the Norwegian Research Council. However, such an approach may work more effectively in biomedical research, as applications are much closer to basic research than say in engineering – concrete problem solving in engineering usually draws on a range of scientific disciplines, not just on a single one, so that it would be more difficult to organise a "one-stop shop"-funding approach in other problem areas.

Scientific communication and international cooperation are very small (except for the FWF, where it however is similar to a collaborative/network type funding scheme) and not used by all agencies.

Overall, the most important funding schemes are hence the following:

- Project Funding (Single Project Funding)
- Funding of People (Careers, Education&Training)
- Infrastructure
- Priority Areas (Structural Priority Areas; thematic focus is however in reality much more explicit, see next section)
- Translation

Table 40: Shares of funding instruments in total yearly funding and change in percentage points between 2017 and the first available year

Country	DE	AT	CH	NL	UK							US		
Agency	*DFG*	*FWF*	*SNSF*	*NWO*	*AHRC*	*BBSRC*	*EPSRC*	*ESRC*	*MRC*	*NERC*	*STFC*	*NIH*	*NSF*	**Average**
Project funding	**36.3%**	**46.3%**	**63.0%**	**10.1%**	**79.5%**	**56.1%**	**100.0%**	**14.4%**	**51.6%**	**64.9%**	**38.8%**	**67.9%**	**49.5%**	**52.2%**
change to first year available	***-6.9***	***-24.8***	***-6.5***	***-32.0***	***+17.1***	***+7.8***	***+0.0***	***-10.1***	***+39.1***	***-8.5***	***-38.4***	***+1.8***	***-10.7***	***-5.5***
Single Project funding (SPF)	30.0%	43.3%	49.6%	10.1%	44.9%	56.1%	100.0%	14.4%	51.6%	64.9%	38.8%	50.4%	46.3%	46.2%
change to first year available	*-8.4*	*-24.7*	*-19.9*	*-32.0*	*-12.2*	*+7.8*	*+0.0*	*-10.1*	*+50.5*	*+17.1*	*-38.4*	*-1.7*	*-5.3*	*-5.9*
SPF Early career	-	3.0%	6.5%	-	4.6%	N/A	N/A	N/A	N/A	-	N/A	0.6%	-	3.7%
change to first year available	*-*	*+3.0*	*+6.5*	*-*	*+4.6*	*N/A*	*N/A*	*N/A*	*N/A*	*-*	*N/A*	*+0.6*	*-*	*+3.7*
SPF high-risk	0.3%	-	-	-	-	-	-	-	N/A	-	-	1.7%	-	1.0%
change to first year available	*+0.3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*N/A*	*-*	*-*	*+1.2*	*-*	*+0.7*
Networks and Multi-Project funding	6.0%	-	6.8%	-	N/A	N/A	N/A	-	N/A	-	N/A	15.2%	-	9.3%
change to first year available	*+1.2*	*-*	*+6.8*	*-*	*N/A*	*N/A*	*N/A*	*-*	*N/A*	*-*	*N/A*	*+1.7*	*-*	*+3.2*
Interdisciplinary research	-	-	-	-	30.0%	N/A	N/A	N/A	N/A	N/A	N/A	0.02%	3.1%	11.1%
change to first year available	*-*	*-3.1*	*-*	*-*	*+25.8*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*+0.02*	*-5.4*	*+4.3*
Priority areas	**44.5%**	**6.7%**	**10.2%**	**11.0%**	**N/A**	**15.5%**	N/A	**21.0%**	**37.1%**	**21.5%**	N/A	**-**	**-**	**21%**
change to first year available	***+3.4***	***-0.6***	***-5.5***	***-9.8***	***N/A***	***+2.0***	***N/A***	***-7.9***	***-8.3***	***+21.5***	***N/A***	*-*	*-*	*-0.7*
Structural priority area	37.5%	5.2%	5.9%	N/A	-	15.5%	N/A	21.0%	37.1%	21.5%	-	-	-	20.5%
change to first year available	*+10.3*	*-2.1*	*-5.8*	*N/A*	*-*	*+2.0*	*N/A*	*-7.9*	*+9.1*	*+21.5*	*-*	*-*	*-*	*+3.8*
Thematic priority area	7.0%	1.5%	4.3%	11.0%	N/A	-	-	-	-	N/A	N/A	-	-	5.9%
change to first year available	*-6.8*	*+1.5*	*+0.3*	*+11.0*	*N/A*	*-*	*-*	*-*	*-17.5*	*N/A*	*N/A*	*-*	*-*	*-2.3*
Infrastructure	**7.3%**	**-**	**4.2%**	**15.9%**	**-**	**14.4%**	**-**	**15.2%**	**-**	N/A	**19.7%**	**4.9%**	**24.1%**	**13.2%**
change to first year available	***+4.6***	***-***	***+4.2***	***+8.5***	***-***	***-12.5***	***-***	***+0.3***	***-***	***N/A***	***+19.7***	***+1.5***	***+9.2***	*+4.4*
Funding of people	**11.4%**	**27.9%**	**14.8%**	**21.7%**	**13.7%**	**11.8%**	N/A	**40.8%**	**11.2%**	**13.6%**	**8.9%**	**6.0%**	**19.3%**	**16.8%**
change to first year available	***+0.9***	***+20.8***	***+3.3***	***+0.4***	***-23.4***	***+2.0***	***N/A***	***+12.6***	***-11.2***	***-13.0***	***-8.5***	***+0.1***	***-1.2***	*-1.4*
Education & Training	6.5%	16.3%	1.2%	N/A	4.3%	-	N/A	21.7%	4.5%	-	N/A	2.5%	12.4%	8.7%
change to first year available	*+0.7*	*+16.3*	*+1.2*	*N/A*	*+4.3*	*-*	*N/A*	*-6.5*	*-4.4*	*-*	*N/A*	*-0.8*	*-5.1**	*+1.6*
Career	3.3%	-	8.1%	N/A	9.4%	11.8%	N/A	19.1%	6.7%	13.6%	8.9%	3.4%	4.0%	8.8%
change to first year available	*+2.1*	*-*	*-3.0*	*N/A*	*-27.7*	*+2.0*	*N/A*	*+19.1*	*-6.9*	*-13.0*	*-8.5*	*+0.8*	*+1.0*	*-3.4*
Diversification	N/A	4.2%	N/A	N/A	-	-	-	-	-	-	-	0.1%	2.9%	2.4%
change to first year available	*N/A*	*+3.5*	*+0.4*	*N/A*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*+0.1*	*+2.9*	*+1.7*
Prizes	0.9%	0.7%	-	N/A	-	-	-	N/A	-	-	-	-	-	0.8%
change to first year available	*-2.5*	*+0.7*	*-*	*N/A*	*-*	*-*	*-*	N/A	*-*	*-*	*-*	*-*	*-*	*-0.9*
Mobility	0.7%	6.7%	5.4%	N/A	N/A	N/A	N/A	-	N/A	-	-	-	-	4.3%
change to first year available	*+0.7*	*+0.2*	*+5.4*	*N/A*	*N/A*	*N/A*	*N/A*	*-*	*N/A*	*-*	*-*	*-*	*-*	*+2.1*
International Cooperation	**N/A**	**12.1%**	**0.5%**	**-**	**N/A**	**N/A**	**-**	**4.3%**	**N/A**	**-**	**-**	**-**	**-**	**5.6%**
change to first year available	***N/A***	***+12.0***	***-1.8***	***-***	***N/A***	***N/A***	***-***	***+4.0***	***N/A***	*-*	*-*	*-*	*-*	***+4.7***
Translation	**0.4%**	**1.8%**	**5.3%**	**18.3%**	**N/A**	**2.2%**	**N/A**	**4.2%**	**N/A**	**N/A**	**18.8%**	**11.8%**	**2.8%**	**7.3%**
change to first year available	***+0.4***	***+1.8***	***+5.3***	***+18.3***	***N/A***	***+0.6***	***N/A***	***+1.2***	***N/A***	***N/A***	***+18.8***	***+2.8***	***-0.2***	***+5.5***
Applied Research	0.4%	1.8%	4.1%	N/A	-	-	-	-	-	-	-	4.3%	-	2.6%
change to first year available	*+0.4*	*+1.8*	*+4.1*	*N/A*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*+2.0*	*-*	*+2.1*
R&D collaboration with firms	-	-	-	N/A	-	2.2%	N/A	4.2%	N/A	-	N/A	3.6%	2.8%	3.2%
change to first year available	*-*	*-*	*-*	*N/A*	*-*	*+0.6*	*N/A*	*+1.2*	*N/A*	*-*	*N/A*	*+1.1*	*-0.2*	*+0.7*
Commercialisation	-	-	1.3%	-	N/A	N/A	-	-	N/A	N/A	18.8%	0.1%	-	6.7%
change to first year available	*-*	*-*	*+1.3*	*-*	*N/A*	*N/A*	*-*	*-*	*N/A*	*N/A*	*+18.8*	*+0.1*	*-*	*+6.7*
R&D Value Chain	-	-	-	-	-	-	-	-	-	-	-	3.8%	-	3.8%
change to first year available	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-0.5*	*-*	*-0.5*
Scientific Communication	**-**	**1.5%**	**0.8%**	**-**	**6.8%**	**-**	**-**	**-**	**N/A**	**N/A**	**-**	**0.7%**	**-**	**2.5%**
change to first year available	***-***	***+1.5***	***-0.2***	***-***	***+6.6***	***-***	***-***	***-***	***N/A***	***N/A***	***-***	***+0.2***	***-***	*+2.1*

Source: Annual Reports and Data of agencies, WIFO calculation. UK Research Councils' and NWO data need to be interpreted with caution; in particular AHRC, NERC and STFC have not validated the information. Note: Note that UK councils sum to 100% in spite of missing information on funding schemes (N/A) as the financial information provided by the councils is different to the information funding applicants receive, see section 3.6.2. Last available year for UK councils: 2016 (except EPSRC) and NWO: 2016. First available year: NIH=1998; AHRC=2006, BBSRC=2014; ESCR=2011; MRC=2002; NERC=2007; STFC=2008; NL=2005; EPSRC, AT, DE and CH=1997, NSF=1997 except of "Education & Training" (change 2017-2010).

Table 41 provides a different perspective on the funding portfolio by calculating a CR3-ratio (i.e., the sum of the shares of the three top programmes). As we have argued in section 2, diversity of funding schemes may matter for quality, quantity and direction of research outcomes, as empirical evidence on what works is often inconclusive and more experimentation and diversity may be needed to address different objectives. Overall, the NIH, NWO and FWF show the lowest concentration, i.e. the highest diversity of funding schemes. By number of original funding schemes (Table 3), the NIH is by far the most diversified agency, followed by the SNSF and the DFG. Note that this analysis is very limited for the UK Research Councils, NWO and for the NSF due to lacking data on detailed funding schemes.

Table 41: Differences in shares of funding schemes: CR3 calculation, 2017

Country	Agency	CR3
DE	DFG	67%
AT	FWF	60%
CH	SNSF	64%
NL	NWO	56%
	AHRC	84%
	BBSRC	98%
	EPSRC	100%
UK	ESRC	56%
	MRC	95%
	NERC	100%
	STFC	77%
	NSF	77%
US	NIH	56%

Source: Annual Reports of agencies, WIFO calculation. Note: CR3-ratio: the sum of the shares of the three top programmes.

Table 42 looks at "who gets the money" – persons, projects, infrastructures, institutions or firms. It does not show very different outcomes then the analysis by funding shares of funding schemes, projects are dominating, ahead of persons/infrastructure.

Table 42: Differences in shares of funding schemes: Who gets funded, 2017

Country	**DE**	**AT**	**CH**	**NL**				**UK**					**US**
Agency	*DFG*	*FWF*	*SNSF*	*NWO*	*AHRC*	*BBSRC*	*EPSRC*	*ESRC*	*MRC*	*NERC*	*STFC*	*NIH*	*NSF*
Person	5%	29%	22%	22%	4%	11%	0%	41%	11%	14%	-	6%	16%
change to first year available	*-4*	*+22*	*+9*	*-18*	*-18*	*-0,3*	*0*	*+13*	*-11*	*-13*	-	*+3*	*+13*
Project	67%	62%	73%	39%	96%	89%	100%	44%	89%	86%	-	77%	46%
change to first year available	*-4*	*-17*	*-15*	*-10*	*+33*	*+0,3*	*-0*	*-13*	*+31*	*+13*	-	*+3*	*-5*
Infrastructure	7%	-	4%	16%	-	-	-	15%	-	-	100%	5%	24%
change to first year available	*+5*	-	*+4*	*+6*	-	-	-	*+0,3*	-	-	*0*	*+2*	*+9*
Institution	20%	5%	-									3%	3%
change to first year available	*+20*	*+5*	-	-	-	-	-	-	-	-	-	*-1*	*-5*
Firms	-	-	-	-	-	-	-	-	-	-	-	-	3%
change to first year available	-	-	-	-	-	-	-	-	-	-	-	-	*0*

Source: Annual Reports of agencies, WIFO calculation. Note: Data for NWO and UK councils (except EPSRC): 2016.

Table 43 gives a feel for the absolute numbers spent on the various funding schemes, showing the tremendous differences. SNSF project funding is almost a third of Germany, although Switzerland is smaller than Germany by a factor of about 10. .

Table 43: Total funding by basic research agencies in Mio. USD on specific schemes, 2017

Country	**DE**		**AT**		**CH**		**NL**		**UK**		**US**			
Agency	***DFG***		***FWF***		***SNSF***		***NWO***				***NIH***		***NSF***	
Classification	Funding in Mio. USD	*Share*	Funding in Mio. USD	*Share*	Funding in Mio. USD	*Share*	Funding in Mio. USD	*Share*	Funding in Mio. USD	*Share*	Funding in Mio. USD	*Share*	Funding in Mio. USD	*Share*
Project funding	1467.2	*36%*	130.6	*46%*	535.3	*63%*	101.1	*10%*	2307.4	*73%*	16856.8	*68%*	3512.8	*49%*
Priority areas	1800.0	*44%*	18.9	*7%*	86.7	*10%*	110.4	*11%*	234.1	*7%*	-	-	-	-
Infrastructure	295.4	*7%*	0.0	*0%*	36.0	*4%*	159.5	*16%*	127.5	*4%*	1207.5	*5%*	1715.0	*24%*
Funding of people	461.1	*11%*	78.8	*28%*	125.9	*15%*	217.9	*22%*	394.4	*12%*	1477.9	*6%*	1373.0	*19%*
International Cooperation	-	-	34.3	*12%*	3.9	*0.5%*	-	-	15.7	*0%*	-	-	-	-
Translation	18.0	*0.4%*	5.0	*2%*	45.3	*5%*	184.0	*18%*	84.2	*3%*	2938.0	*12%*	199.1	*3%*
Scientific Communication	-	-	4.4	*2%*	6.8	*1%*	-	-	6.0	0%	179.6	*1%*	-	-
Total	**4046.0**	***100%***	**282.1**	***96%***	**849.9**	***99%***	**1003.6**	***77%***	**3169.3**	***100%***	**24814.3**	***91%***	**7102.7**	***96%***

Source: Annual Reports of agencies, WIFO calculation. Note: Conversion rates PPP, 2017: CH=1.22; DE=0.78; NL=0.82; UK=0.71. Data for NWO and UK: 2016.

Table 44 shows the shares of four broad disciplines (medicine, natural sciences, engineering, social sciences&humanities as well as interdisciplinary research) in the total funding by the agencies (see section 3.1). As outlined, this should be interpreted with care, as we do not survey all the research grant funding agencies in the

various countries, nor do we look at the share of disciplines in block-funded higher education research.[11] According to NWO, data for the Netherlands cannot be split by discipline. In all countries except for the US, natural sciences achieve the highest share in overall funding. The share of medicine is comparable in Switzerland, Germany and the UK at above 20%, although there are other funders of medical and health research in the UK such as the National Institute for Health Research (https://www.nihr.ac.uk/), and The Chief Scientists Office (part of the Scottish Government Health Directorate - http://www.cso.scot.nhs.uk/). In the US, medicine achieves an extremely high share of close to 80% due to the dominance of the NIH; however, engineering and physical sciences are also funded by the Department of Defense and the Department of Energy, and others which are not included here.[12] Otherwise, engineering receives a small share in most agencies, but is most important in Germany, about twice as high than in the UK, Switzerland and the US and very low in Austria. Social Sciences and the Humanities are at an astonishing 22% in Switzerland and Austria, and at approx. 15% in Germany and the UK, while only at 1% in the US. Interdisciplinary research has only got some importance in Germany, although data need to be interpreted with care – the FWF and UK councils explicitly accept interdisciplinary projects, but data are not separately shown in the table below.

In terms of change over time, there does not seem to be a clear pattern, except for the natural sciences which lose some share everywhere, except for Austria. Section 3 shows the evolution of disciplines' shares over time in single project funding for the individual agencies.

Table 44: Shares of disciplines in Single project funding, change in percentage points between 2017 and first available year

Country	**DE**		**AT**		**CH**		**NL**		**UK**		**US**		
Agency	***DFG***		***FWF***		***SNSF***		***NWO***				***NIH & NSF***		
	Share	*change to first year available*	Share	*change to first year available*	Share	*change to first year available*	Share	*change to first year available*	Share	*change to first year available*	Share	*change to first year available*	**Mean (last year)**
Medicine	22%	*+4*	12%	*-3*	21%	*-4*	N/A	*N/A*	24%	*+2*	79%	*+2*	32%
Social Science and Humanities	15%	*-1*	22%	*-1*	22%	*+8*	N/A	*N/A*	13%	*+0*	1%	*-1*	15%
Natural Sciences	36%	*-4*	61%	*+2*	48%	*-7*	N/A	*N/A*	40%	*-7*	12%	*-3*	39%
Engineering	20%	*-5*	5%	*+2*	9%	*+4*	N/A	*N/A*	11%	*+2*	7%	*+1*	10%
Interdisciplinary	7%	*+7*	N/A	*N/A*	-	-	N/A	*N/A*	N/A	*N/A*	0,25%	*+0,25*	4%

Source: Annual Reports of agencies, WIFO calculation. Note: Last year available: UK=2016, First year available: CH=1997; DE, US=1998; AT=2009; UK=2011. UK disciplines are equivalent to the funding of the individual research councils (Medicine MRC, SSH AHRC&ESRC, Natural Sciences BBSRC, NERC, Engineering EPSRC. The shares of the UK disciplines do not result in 100% as 10% infrastructure (STFC) is not included in this table. The FWF and UK councils accept interdisciplinary projects, but data are not shown in this table.

4.4 Differences in how agencies allocate funding: grant design and characteristics

In this section, we focus on the differences between grant funding features such as success rate, lot size and funding duration. We first focus on the main (single) project funding scheme of each agency, as they are in principle most comparable, and the data availability is best for these funding schemes. In separate sub-sections, we examine the different cost reimbursement modalities and the peer review procedure in the main project funding schemes. Data availability is less good for other funding schemes and moreover, they may be different in many ways which make them difficult to compare. Nevertheless, we present some data on these other schemes in the last sub-section, including also some data at the aggregate level relevant for characterizing the differences in how agencies allocate their funding, including the prevalence of bottom-up vs top-down (or curiosity-driven vs solicited research) schemes.

4.4.1 Characteristics of the main (single) project funding scheme

The next Table 45summarises our findings on the characteristics of (single) project funding. Note that in the case of the UK Research Councils (and partly the NSF), the standard research grants can accommodate several types of proposals or mechanisms, including e.g. single- or multi-investigator schemes, collaborations with firms, or different durations and aims as with the NSF main mechanisms (see section 3).

[11] Total federal funding of basic and applied R&D by scientific field can be found here: https://www.nsf.gov/statistics/2018/nsb20181/figures/fig04-12.

[12] See the previous footnote. Life sciences still largely dominates, even considering all other federal research funding.

Table 45: Single project funding, 2017

Country	Agency	Program	Max Lot Size (according to documents) in Mio. EUR	Lot Size (statistical) in Mio. EUR	Lot Size (change to first year available)	Max Project Period (according to proposal guidelines)	Success Rate	Success Rate (change to first year available in percentage points)	Share Bottom-Up	Share Bottom-Up (change to first year available in percentage points)	Discipline-specific yes/no
DE	DFG	Research Grants	N/A	0.28	N/A	3 years	30%	-5	100%	N/A	no
AT	FWF	Stand-Alone Projects	0.4	0.33	+0.23	4 years	29%	-30	100%	0	no
CH	SNSF	Project funding	>0.05	0.5	+0.13	1-4 years	48%	-10	91%	N/A	no
NL	NWO	Open Competition	N/A	0.33	-0.03	6 years	22%	-1	100%	N/A	no
UK	AHRC	Research Grants (Standard)	0.6-1.2	0.64	+0.19	5 years	25%	-1	100%	N/A	yes
	BBSRC	Research grants	2.2	N/A	N/A	5 years	24%	+2	58%	N/A	yes
	EPSRC	Research grants	not limited	0.98	+0.83	N/A	29%	-8	58%	+32	yes
	ESRC		0.4-1.2	N/A	N/A	N/A	23%	+4	43%	N/A	yes
	MRC	Research Grant	1.2	N/A	N/A	5 years	22%	-1	N/A	N/A	yes
	NERC	Research grants	0.98	N/A	N/A	N/A	31%	+10	N/A	N/A	yes
	STFC	Research grants	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	yes
US	NIH	R01	not limited	0.41	+0.15	3-5 years	19%	-12	N/A	N/A	yes
	NSF	Research	0.15	0.34	-0.18	2.9 years*	21%	-3	N/A	N/A	yes

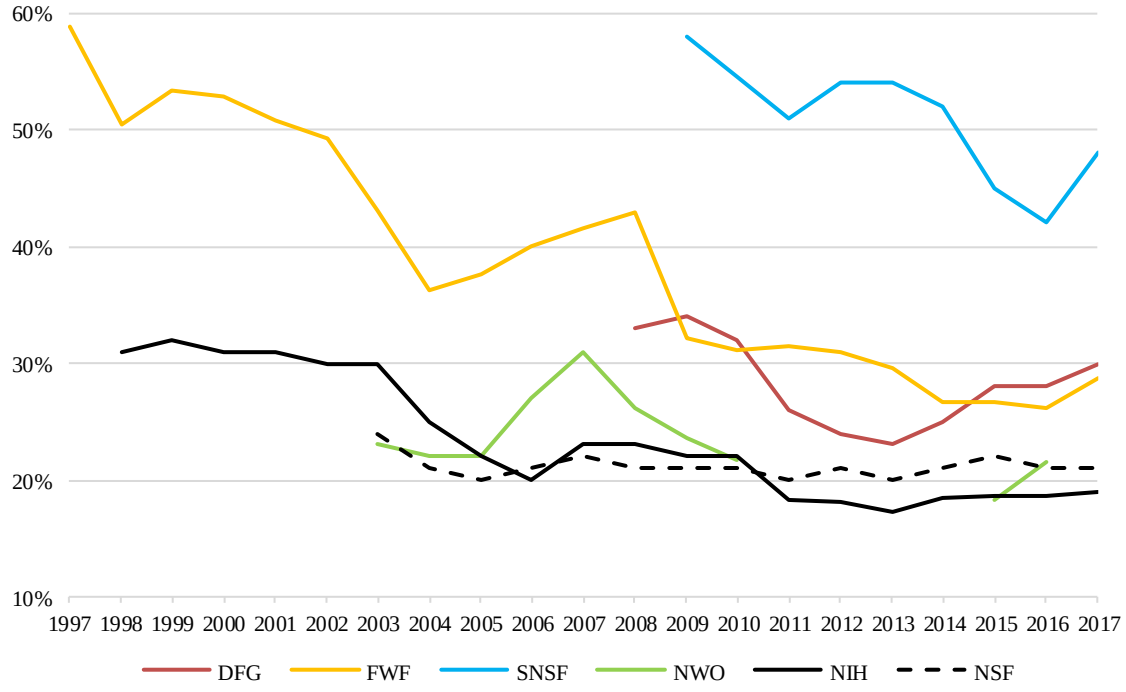
Source: Annual Reports of agencies, specific data provided by agencies, WIFO calculation. Note: "not limited" = the budget is not limited unless specified in the FOAs. It needs to reflect the actual needs of the proposed project. * average duration (years). Note that the UK Research grants and the NSF Research schemes are broader schemes, so that the data need to be interpreted with caution. For BBSRC, ESRC and NERC the success rate covers all funding instruments, for AHRC, EPSRC, MRC the success rate refers to single project funding only. All data refer to new awards, except for the NIH, where the lot size and success rate refer to all types of awards, including new awards, renewals and revisions. Last available year for NWO and UK councils (except EPSRC): 2016.

- Success rates

Starting with success rates, they vary from 19% for the NIH R01 grants to 48% in the Swiss single project funding scheme. There is a tendency for declining success rates at the bigger agencies (in particular, NIH -12 percentage points, SNSF -10 percentage points, albeit from very high levels), only some smaller UK agencies see increasing success rates. To properly judge success rates, they should be compared with the number of applications, controlling for scale. Figure 49 shows the number of applications over time relative to population, where Switzerland and the US achieve the highest number of applications, so that the high Swiss success rate cannot be due to a small number of applications. Germany also achieves a comparatively high success rate, which had actually dropped by more than 5 percentage points but then started to increase again since 2013 (Figure 46 and Figure 47, success rates over time); the number of applications relative to population is in between Switzerland and the US at the top and the Netherlands and the UK at the bottom. Relative to the number of higher education researchers in full time equivalents (Figure 50), Germany is at par with Switzerland which has declined in recent years. The success rate at the Austrian FWF is also in the higher range.

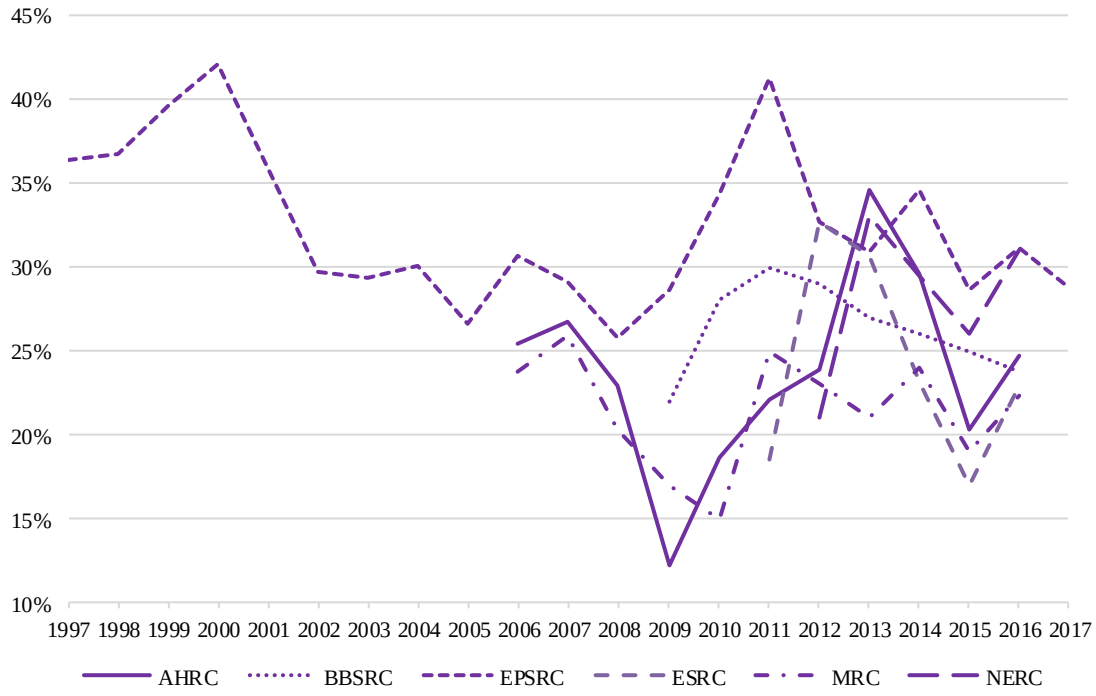
Success rates need to be interpreted with care independently of the number of applications. For example, agencies may use outline proposals to do a first check, which don't enter the number of applications. And within (single) project funding, investigator-initiated and solicited research proposals may coexist (such as in the UK and in the US), which also limits comparability of overall success rates, although the bulk of R01 NIH (74%) grants and also the majority of e.g. EPSRC grants (58%) are investigator-initiated grants (Table 45). The importance of the success rate for the academic research enterprise is stressed in many publications (see section 2).

Figure 46: Success rates in Single project funding, 1997-2017



Source: Annual Reports of agencies. Note: Name of the programs in Single project funding: SNSF=Project funding, DFG=Research Grants, FWF=Stand-Alone Projects, NWO=Open Competition, NIH=R01, NSF=Research. Note that the NSF scheme is a broader category.

Figure 47: Success rates UK Research Councils, 1997-2017



Source: Annual Reports of agencies. Note: for BBSRC, ESRC and NERC this funding rate covers all funding instruments, for AHRC, EPSRC, MRC the funding rate refers to single project funding only.

Success rates across disciplines (Table 46) are available for the discipline-specific Research Councils (NIH, UK Research Councils) as well as for the DFG and the SNSF. The DFG aims at stable success rates across disciplines, which can be seen from relatively low spread between disciplines (see also section 3 for a time series); engineering is somewhat above the three other broad disciplines. Switzerland shows stronger differences across disciplines,

from 35% in medicine to 57% in natural sciences, with engineering and SSH (social sciences&humanities) in between.

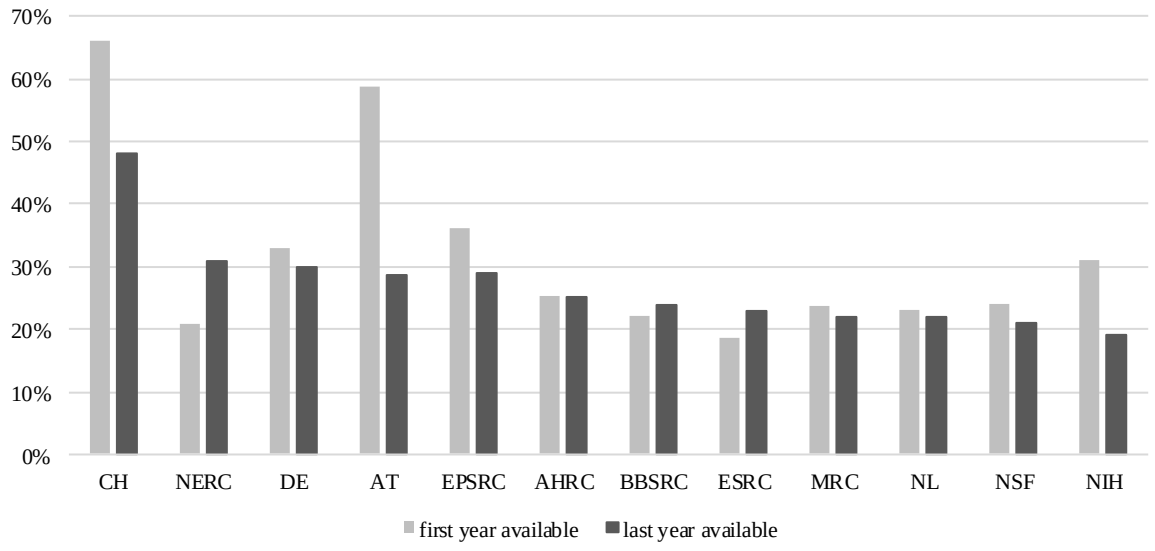
Table 46: Success Rates by disciplines in Single project funding, 2017

Country	Agency	Program	Engineering	Medicine	Natural Sciences	Social Science and Humanities
DE	DFG	Research grants	35%	29%	28%	31%
AT	FWF	Stand-Alone Projects	18%	22%	25%	24%
CH	SNSF	Project funding	43%	35%	57%	45%
NL	NWO	Open Competition	N/A	N/A	N/A	N/A
UK			29%	23%	27%	25%
US	NIH	R01	-	19%	-	-
	NSF	Research	18%	-	25%	20%

Source: Annual reports and websites of agencies. Note: Disciplines proposed by WIFO. Note that the UK success rates have been approximated through weighting the Councils' shares in total funding of disciplines and refer to 2016. DFG: Medicine success rate relates to Life Sciences in Total. Note that the success rates for FWF refer to the proportion of the granted funding in relation to the requested funding.

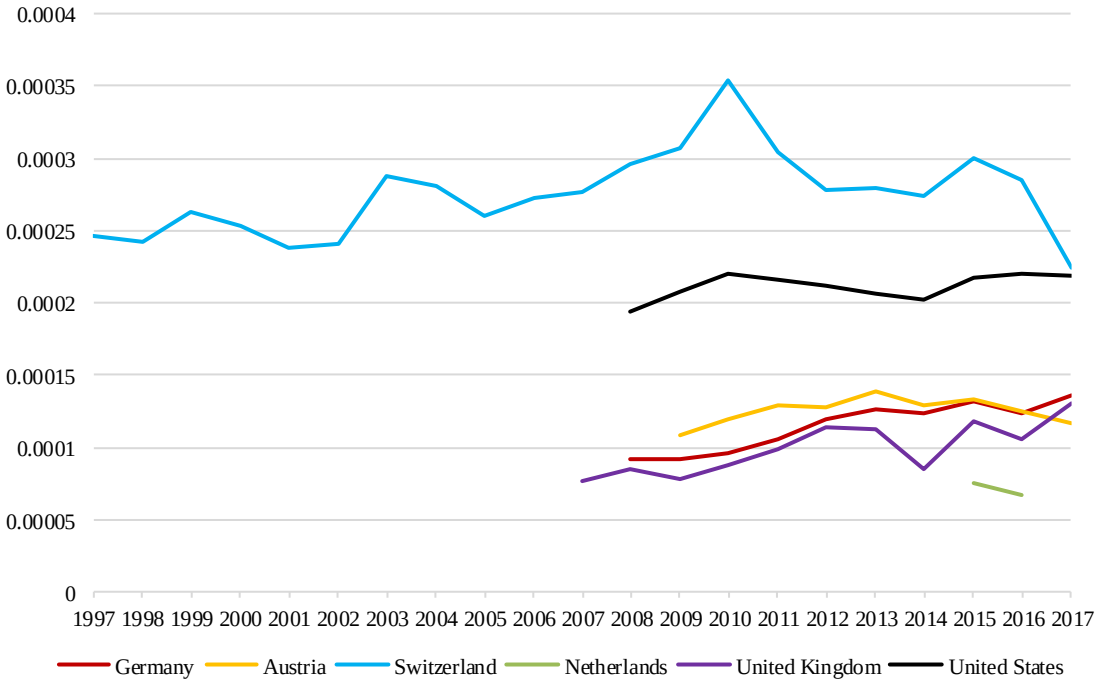
At the level of the agencies, the results are not very different from the main project funding scheme, as the latter achieves the highest share in almost all agencies.

Figure 48: Success rates in Single project funding, first and last available year



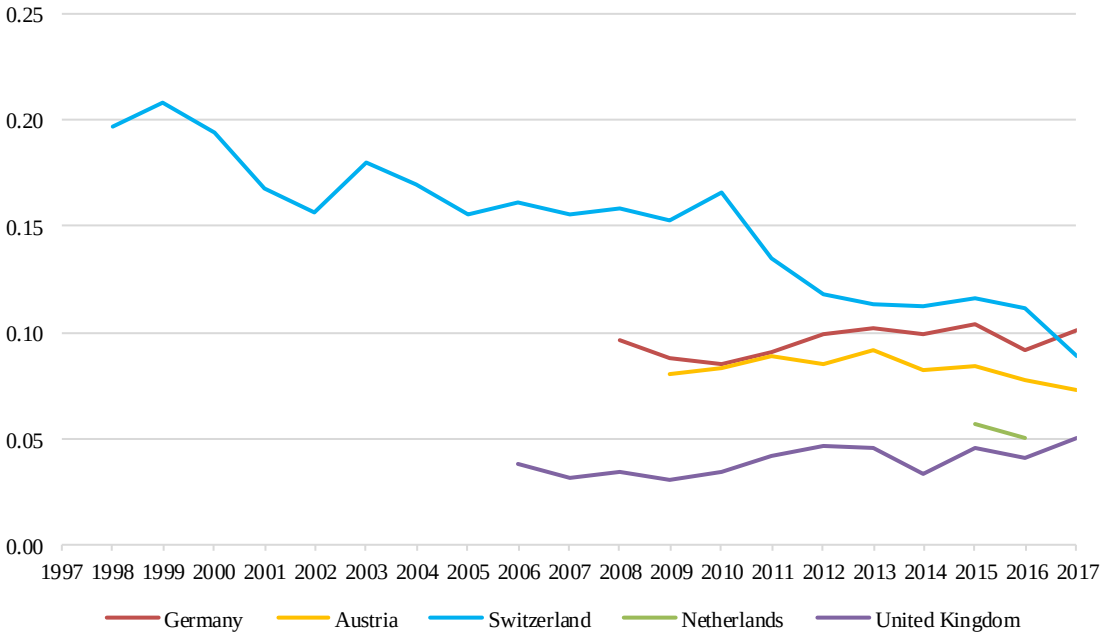
Source: Annual Reports of agencies. Note: UK summarizes AHRC, BBSRC, EPSRC, ESRC, MRC, NERC – no data available for STFC. Last year available=2017, except NERC, AHRC, BBSRC, ESRC, MRC, NL=2016. First year available: AT, CH, NL, NSF=2003; NERC=2012; DE=2008; EPSRC=1997; AHRC, MRC=2006; BBSRC=2009; ESRC=2011; NIH=1998.

Figure 49: Number of applications submitted in Single project funding relative to population, 1997-2017



Source: Annual Reports of agencies, OECD-MSTI variable used "Population", WIFO calculation. Note: There is a break in the US data, as NSF data are only available since 2008. Note that FWF and DFG applications include all withdrawn, cancelled, rejected or approved applications.

Figure 50: Number of applications submitted in Single project funding relative to HER in full time equivalents, 1997-2017



Source: Annual Reports of agencies, OECD-MSTI variable used "Higher Education Researchers (FTE)", WIFO calculation. Note: No data available for the US. Note that FWF and DFG applications include all withdrawn, cancelled, rejected or approved applications.

- Curiosity-driven vs. solicited ("Share Bottom-up"), discipline-specific vs. open to all disciplines

FWF, NWO, the DFG and SNSF only fund curiosity-driven, principal investigator-initiated research in their single project funding schemes. The US and UK agencies, by contrast, feature also some solicited research, although we have data only for the NIH, BBSRC and EPSRC. The same holds true for whether the single-project funding schemes are open to all disciplines or whether they are structured by scientific discipline (see next section).

Moreover, in all agencies apart from the DFG, FWF and the SNSF, standard research grants are also used for thematic calls (pre-defined thematic framework, but research questions asked by researchers, i.e. bottom-up) and review criteria include knowledge use or economic/societal impact. Relative to its size, the SNSF runs as a consequence the biggest curiosity-driven, bottom-up scheme without thematic focus and based on scientific criteria only (note though that researchers can field proposals which are use-inspired on a self-declared basis).

- Funding duration

Here we have some missing data, and a mix between information from the proposal information guidelines and statistical funding duration. Average funding duration in the US is quite short (NSF 2,9 average, NIH 3,6 average, but up to 5 years allowed), as well as maximum funding duration according to proposal guidelines in Germany (3 years). Switzerland and Austria allow up to 4 years, most UK Councils up to 5 years and the Netherlands is at 6 years. Note that within single grant funding schemes, special provisions may exist, e.g. in Germany it is possible to ask for long-term funding for up to 12 years. Moreover, to properly judge funding horizons, the possibility of renewability of grants must be accounted for. Table 47 shows that renewing grants is possible in most agencies, only exceptionally in Switzerland and not at all in the Netherlands, which has however the longest funding duration to start with. Success rates for renewal are higher in Germany and at the NIH as well as about the same at the NSF; no data exist for the UK Councils. As a share of grants, renewals are most common at the NIH, followed by Germany.

Table 47: Renewability of grants in single project funding, 2017

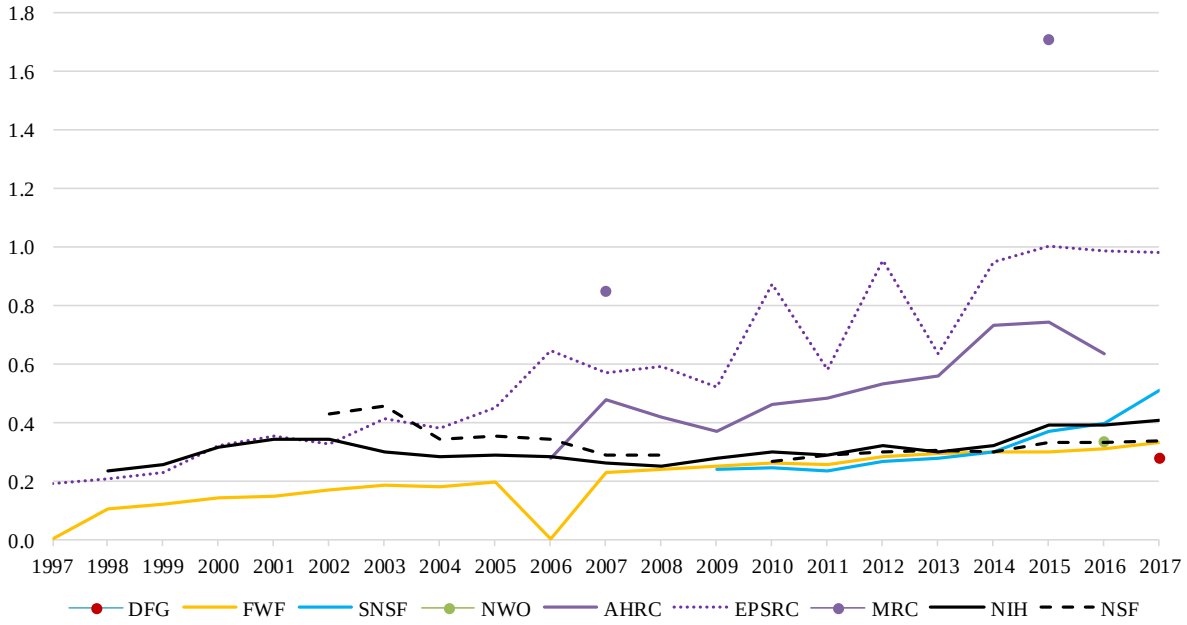
Country	Agency	Program	Renewal	Probability of renewal vs. first-time application success rate	Share of renewals in total grants
DE	DFG	Research Grants	possible	higher	14%
CH	SNSF	Project funding	exceptionally (excellence)	-	1.7%
AT	FWF	Stand-Alone Projects	not renewable (a new proposal must be submitted)	N/A	N/A
NL	NWO	Open Competition	not renewable	-	-
UK	EPSRC	Research Grants	possible	N/A	N/A
US	NIH	R01	possible	higher	27%
	NSF	Research	possible once	equal	N/A

Note: The NSF Research schemes are broader schemes, so that the data need to be interpreted with caution.

- Lot/average grant size

Finally, we have information on lot size, mostly statistical. Although lot sizes should ideally be compared on a discipline-specific basis, as equipment-heavy disciplines will feature higher average lot sizes than social sciences, (this is visible in the data, as EPSRC has by far the highest lot size), the share of disciplines in overall funding is quite comparable between the European countries, so that our lot sizes are to some extent comparable. They vary between 0,26 to 0,5 Mio. Euros, with the DFG at the lowest end of lot size and the SNSF at the highest end (despite the high share of social sciences and humanities). This also puts the success rates reported above in perspective, in that it further adds to the picture of the SNSF being the agency providing not just the highest success rates, but also the biggest grants, while the relatively high success rate of the DFG and of the FWF is partly explained by on average lower lot sizes. Figure 51 shows lot size over time.

Figure 51: Lot size in Single project funding, in Mio. EUR, 1997-2017



Source: Annual Reports of agencies, WIFO calculation. Data for DFG for 2017 (research grants): 0.28 but no data for time series; similar for NWO and MRC. The high value of MRC in 2015 is partly due to the high euro-pound exchange rate.

4.4.2 Differences in cost reimbursement

A major characteristic of funding schemes is the way indirect costs and salaries of principal investigators are reimbursed, as this affects the dynamics of the scientific labour market and the overall dynamics of scientific growth in a country (see section 2). As the next table shows, refundable costs are quite similar across the agencies in single project funding (knowledge creation should need fairly similar resources independently of where it happens), with the exception of the salaries of the PIs and indirect costs (not paid at all in the Netherlands and in Austria). The way indirect costs are reimbursed differs a lot (Table 49): while in principle, US federal research grants reimburse all indirect costs (ranging from 30-69% of direct costs, depending on the university), the indirect cost rate is only at 20% in Switzerland and 22% in Germany. It can be argued whether US universities receive full indirect cost, as establishing "full" indirect costs is inherently difficult and subject to federal audits (*Stephan, 2012*). The UK cannot be directly compared, as the Councils pay 80% of full economic cost, which leaves 20% of total project cost to be covered by the research institution hosting the researcher. The research time of the principal investigator in the UK is part of the full economic cost (i.e., they cannot "buy out" their teaching time, but their research time is covered by the grant), so that from the perspective of the hosting research institution a UK grant may come with fewer co-financing requirements than a SNSF or DFG grant. Note that there are specific schemes or modules within standard research grant schemes of the SNSF, FWF, NWO and DFG where the principle investigators (mostly non-tenured) can put their salary on the proposal or buy out their teaching time, e.g. at the DFG researchers can ask for a 12-month teaching replacement within the standard single project funding scheme.

Table 48: Refundable costs in standard Single project funding, 2017

Country	DE	AT	CH	NL	UK	US	
Agency	*DFG*	*FWF*	*SNSF*	*NWO*		*NIH*	*NSF*
Wages of the principal (tenured) investigators					x	x	x
Wages of scientific/technical staff	x	x	x	x	x	x	x
Material expenses	x	x	x	x	x	x	x
Mobility	x	x	x	x	x	x	x
Third-party expenses	x		x	x		x	x
Costs of scientific (open access) publications	x	x	x		x*	x	x
Administrative/indirect costs	x		x		x	x	x

Source: Assessment by WIFO based on information provided by agencies. Note: *Costs for publications, such as books, monographs, etc. Exceptions are journal articles and conference proceedings.

Table 49: Share of indirect costs/overheads relative to direct costs, 2017

Country	DE	AT	CH	NL	UK	US	
Agency	*DFG*	*FWF*	*SNSF*	*NWO*		*NIH*	*NSF*
Indirect cost rate	22%	-	20%	-	No indirect cost rate: 80% of full economic cost is paid to institution, i.e. 20% of total cost has to be financed by institution	Full coverage of indirect costs in all federal research grants, institutions negotiate individual rates, on average 54.4% for private, 46.5% for public universities, range 30-69% in 2010)	

Source: Assessment by WIFO based on information provided by agencies.

4.4.3 Differences in single project funding peer review

To ensure the overall quality of the review process, all agencies have a more or less similar three stage set up of the peer review process of the standard principal investigator research grants. In the first stage, mostly ad hoc selected external academic reviewers provide the peer assessment of the proposal, then there is a sort of quality control and prioritisation in a second stage, where usually external scientists nominated to participate in a kind of "review board" for a period for several years, as well as agency staff, discuss the assessments provided by the first stage reviewers and provide a funding recommendation for a third stage, where the agencies' executive bodies reach a final funding decision (based on the results of the first two stages). Differences between agencies are shown in Table 50 and Table 51 below and based on the findings from the literature survey in section 2 relate to the

- Organisation of the peer review process itself (safeguarding the overall quality of the review process)
  - How the first stage review process is organised (mail vs. panel review, i.e. first stage peer reviewers come together to discuss proposals in person, rather than just the second-step quality control reviewers discussing the first-stage reviews),
  - Whether the second stage involves a different set of external academic reviewers
- Selection/Size of reviewer pool
  - Where first stage peer reviewers come from (national/international, academic/non-academic)
  - Selection of second stage reviewer pool (chosen by agency or elected by scientific community)
- Nature and weight of first stage review criteria
  - Number of criteria
  - Criteria type, e.g. whether the potential economic or societal impact of the proposed research, or the utilisation of the knowledge created is an assessment criterion
  - Special criteria for e.g. first-time applicants (other features such as interdisciplinarity are usually dealt with by dedicated review panels)
- Rights for applicants/information provided to them
  - Refusal or nomination of reviewers
  - Appeal/feedback to reviewer comments
  - Information provided to applicants from review

First, starting from Table 50, first stage reviewers are mostly academic researchers, with the exception of UK Research Councils and NWO, which will also ask non-academic experts about the potential of applications (particularly with regard to potential impact). Reviewer nationality (and hence the size of the potential reviewer pool) is mostly determined by country size. In small countries, they are predominantly or not at all working in the country of the agency (Austria, Switzerland, Netherlands), in mid-size countries (Germany, UK) both national and international reviewers are solicited, while in the US, reviewers are mostly working within the US. Second stage reviewers (who often serve on boards for a longer period of time) are elected by the scientific community in Austria, Germany and Switzerland (in Switzerland intermediated by the Executive Committee of the Research Council), reflecting the strong role of the scientific community in these agencies discussed in section 4.1.3. They are chosen by the agencies in the other countries, sometimes out of a pre-existing pool of reviewers such as the Peer Review College of the EPSRC (which is also used for first stage reviewers). In some countries, second stage reviewers must be distinguished researchers such as in Switzerland, whereas in the case of the EPSRC in the UK no distinction is made.

Second, concerning the peer review process, only the NIH differs in that all of its first stage reviewers will also convene in person to discuss the applications (the NSF has the option to do a first stage panel review, other agencies will only do so in the case of a high number of applications). Only the NSF does not have standing groups of external researchers to discuss the first stage reviews in the second stage, giving the NSF Program Officer more discretion in discriminating between proposals, as also *Stephan (2012)* notes.

Table 50: Summary table: Organisation of peer review of and criteria used in Single project funding, 2017

Country	**DE**	**AT**	**CH**	**NL**	**UK**	**US**	
Agency	*DFG*	*FWF*	*SNSF*	*NWO*	*EPSRC*	*NIH*	*NSF*
Reviewers							
External and internal (1. and/or 2. stage of review)	x	x	x	x	x	x	x
First-stage external reviewers only academics/researchers	x	x	x[1]			x	x
First-stage external reviewers predominantly national						x	x
First-stage external reviewers national and international	x				x		
First-stage external reviewers predominantly international		x	x	x			
Second stage reviewers elected/nominated by scientific community	x	x	(x)				
Second stage reviewers chosen by agency				x	x	x	x
Review Process							
First stage predominantly mail review	x	x	x	x	x		(x)
First stage predominantly panel review						x	
Second stage involves discussion of proposals among "review boards" (external researchers different to first stage-researchers discuss proposals)	x	x	x	x	x	x	
Rights of Applicants							
Applicants can suggest reviewer(s)					x		x
Applicants can refuse specific reviewers		x	x			x[2]	x
Applicants have no influence on reviewer selection	x						
Applicants can provide feedback to/appeal against reviewers' comments				x	x	x	
Review Criteria							
Number of criteria	5	4	3	4	5	5	6
Explicit weights for criteria	N/A	N/A	N/A	Yes	Yes	N/A[3]	N/A
Special criteria for first time applicants	Yes	Yes	No[4]	No[4]	No[4]	Yes	No
Impact or applicability/utilisation of research is a criterion	No	No	No[5]	Yes	Yes	Yes	Yes

Source: Assessment by WIFO based on websites of agencies. Note: [1] With the exception of proposals declared as use-inspired. [2] Applicants are informed about the assignment of the Scientific Review Group and may ask for reconsideration. [3] According to Stephan 2012, the criteria most highly correlated with the overall impact score are approach and significance. [4] There are specific first-time applicant/early career PI-schemes. [5] Only for proposals for use-inspired research.

Third, differences in the criteria reviewers should follow to assess proposals are probably most striking across the agencies (Table 51). While all agencies ask reviewers to assess the scientific quality of the proposal, the aptitude

of the applicant, and feasibility, some agencies barely have criteria for the potential non-scientific impact of the project (Austria, Germany, Switzerland), while others such as the EPSRC have even two criteria relating to this (one for overall impact, one for specifying how well pathways are described to reach the impact). This is also a main source for the difference in the number of criteria to be assessed, with other differences relating to the necessary assessment of the research and work environment (only asked by DFG and NIH) as well as the appropriateness of the funding plan (asked by the DFG, EPSRC and NSF). However, some of the two latter criteria may be part of the more general feasibility criterion used in all agencies.

Only two agencies/countries provide explicit weights for the criteria (NL and UK), usually emphasizing the quality of the project rather than the capability of the applicant. Generally, the formulation of criteria and weights where existing, as well as research on the correlation of funding decisions/overall scores with partial scores (see *Stephan 2012* and section 3), indicate that proposal features or the assessment of the research are more important than the applicant's qualifications (whereas the literature both finds that it is easier to assess the potential of people rather than projects and that schemes stressing people over project selection may lead to higher impact research (see section 2)).

The DFG, FWF and NIH feature specific assessment criteria for first-time applicants within the standard single project funding, all others except for the NSF have dedicated early career PI schemes.

Table 51: Summary table: Review criteria in detail, 2017

	DE	AT	CH	NL	UK	US	
Dimension	*DFG*	*FWF*	*SNSF*	*NWO* [1]	*EPSRC*	*NIH*	*NSF*
Overall impact	NA	Included in proposal, but not subject to decision	NA	Yes	Importance (contribution to health of other disciplines, economic success, societal challenges, world leading activity, complementary to other UK funding)	Significance (importance of problem addressed, contribution to knowledge creation, technical capability/clinical practice, likely change potential for methods, treatments etc.)	Overarching: proposals are reviewed for their intellectual merit (potential to advance knowledge) and broader impacts (potential to benefit society); Both criteria are to be given full consideration during the review (the elements below need to be examined for intellectual merit and broader impact)
Scientific Quality of project	Scientific quality of the project	Scientific quality of the project	Scientific quality of the project	Yes	Quality (novelty and feasibility)	Innovation (novelty of approach, methods, etc.)	[Novelty] - to what extent do proposed activities suggest and explore creative, original, or potentially transformative concepts
Qualifications of investigator	applicants' qualifications	applicants' qualifications (based on academic age)	scientific track record	Yes	Applicant (PI's track record and team quality)	Potential/track record of investigator	How well qualified is the individual, team, or organization to conduct the proposed activities
Feasibility	suitability of methods and feasibility	Approach/methods and feasibility	suitability of methods and feasibility	Yes	(included in quality)	Approach (feasibility and suitability of approach, methods etc.)	Is the plan for carrying out the proposed activities well-reasoned, well-organized
Suitability of environment	Work and research environment	NA	NA	No	NA	Environment (Will scientific work environment contribute to chances of success?)	NA
Funding resources	Appropriateness of funding	Included in proposal, but not subject to decision	NA	No	Resources and management (appropriateness of resources)	NA	adequate resources available?
Pathways to project impact	NA		NA	Yes	Impact (completeness of impacts, effectiveness of activities to help realise the impacts, appropriateness of collaborators)	NA	NA

Source: Websites of agencies. Note:1 NWO has different formulations of criteria according to the various single-project funding schemes (see section 3, but the coverage of the general categories is indicated).

Review information provided to applicants

- The DFG notification letter contains reasons for rejection; all the reviews of external reviewers are forwarded to the applicants, along with a written summary of the discussions in the relevant bodies in the second stage.
- FWF applicants with negative decisions will receive the first stage reviews and a standardised rejection information, but not informal comments made in the second stage.
- SNSF applicants with negative decisions will receive the relative rating, the main grounds for rejection as well as the external reviews
- NWO applicants are sent the reviewers' reports before the second stage to be able to respond, but not a summary of the discussion at the second-stage selection committee discussions
- EPSRC Applicants get first stage reviewer comments before the second stage (to be able to comment), but do not receive additional information from the second stage (panel review), as it is argued that the aim of the second stage is simply a ranking of the proposals
- NIH Reviewer critiques and summary scores are released to the applicant, as well as the SRO's summary of the discussion at the panel review
- NSF Everything except for names of reviewers (the information provided to applicants is explained in detail on the NSF website)

Allowing applicants to respond to reviewers is said to build trust in the peer review system (NWO, 2017).

4.4.4 Selected characteristics of funding agencies' activities at the aggregate level

The next Table 52 shows the share of discipline-specific funding schemes in total agency funding; here, only Germany does not show any discipline-specific funding schemes, while the SNSF shows a very small share and the NWO spends half of its money on discipline-specific schemes (data to be interpreted with care).

Table 52: Shares of discipline-specific programmes vs. non-specific programmes, 2017

Country	Agency	Share of discipline-specific (2017)	Change to first year available
DE	DFG	0%	-2
AT	FWF	3%	+3
CH	SNSF	8%	+8
NL	NWO	48%	N/A
UK	AHRC	100%	0
	BBSRC	100%	0
	EPSRC	100%	0
	ESRC	100%	0
	MRC	100%	0
	NERC	100%	0
	STFC	100%	0
US	NIH	100%	0
	NSF	100%	0

Source: Annual Reports and websites of agencies, WIFO calculation. Note: Data for NWO and UK councils (except EPSRC): 2016.

Data for bottom-up vs top-down schemes in total at the level of the agencies are much harder to come by (Table 53), from the available data the DFG and FWF are fully bottom-up, while the SNSF has some top-down programmes.

Table 53: Share of Top-Down vs. Bottom-Up in total, 2017

Country	Agency	Top-Down	Bottom-Up
DE	DFG	0%	100%
AT	FWF	0%	100%
CH	SNSF	7%	91%
NL	NWO	0%	100%
	AHRC	30%	70%
	BBSRC	42%	58%
	EPSRC	42%	58%
UK	ESRC	57%	43%
	MRC	N/A	N/A
	NERC	N/A	N/A
	STFC	N/A	N/A
US	NIH	N/A	N/A
	NSF	N/A	N/A

Source: Annual Reports and websites of agencies, as well as specific data provided by agencies. Note: Data for BBSRC, EPSRC and ESRC are the share of top-down/bottom-up funding in standard research grants, not total. Data for NWO and UK councils (except EPSRC): 2016.

Table 54 and Table 55 present all available success rates and funding durations across the funding spectrum of the agencies. Success rates for infrastructure investments are usually higher than for project funding. Otherwise, there is a wide range of success rates for the various individual programmes (see characterisation of agencies in section 3), which would need more detailed investigation than is possible within the scope of this study. The same holds true for funding duration across the funding spectrum of the agencies.

Table 54: Success rates over funding schemes, 2017

Country	**DE**	**AT**	**CH**	**NL**				**UK**				**US**	
Agency	*DFG*	*FWF*	*SNSF*	*NWO*	*AHRC*	*BBSRC*	*EPSRC*	*ESRC*	*MRC*	*NERC*	*STFC*	*NIH*	*NSF*
Project funding													
Single project funding (SPF)	30%	29%	48%	22%	25%	N/A	29%	N/A	22%	N/A	N/A	14-100%	21%
SPF Early career	-	7%	31-36%	-	55%	N/A	N/A	N/A	24%	-	N/A	N/A	-
SPF high-risk	N/A	-	-	-	-	-	-	-	N/A	-	-	10-38%	-
Networks and Multi-Project funding	N/A	-	N/A	-	-	N/A	N/A	-	14%	-	N/A	23-50%	-
Interdisciplinary research	-	-	-	-	41%	N/A	N/A	N/A	N/A	N/A	N/A	22%	N/A
Priority areas													
Structural priority area	N/A	5%**	N/A	N/A	-	N/A	N/A	N/A	34-67%	N/A	-	-	-
Thematic priority area	N/A	13%	N/A	39%	N/A	-	-	-	-	N/A	N/A	-	-
Infrastructure	**N/A**	**-**	**71%**	**62%**	**-**	**N/A**	**-**	**N/A**	**-**	**N/A**	**N/A**	**21-51%**	**N/A**
Funding of people													
Education&Training	N/A	16-25%*	27-100%	N/A	28%	-	N/A	N/A	86%	-	N/A	34-100%	N/A
Career	N/A	-	16-56%	19%	38%	N/A	N/A	N/A	18%	N/A	N/A	14-100%	N/A
Diversification	N/A	23-25%	N/A	N/A	-	-	-	-	-	-	-	N/A	N/A
Prizes	N/A	5%	-	N/A	-	-	-	N/A	-	-	-	-	-
Mobility	N/A	24-36%	36-47%	N/A	N/A	N/A	N/A	-	N/A	-	-	-	-
International Cooperation	**N/A**	**N/A**	**N/A**	**-**	**N/A**	**N/A**	**-**	**N/A**	**N/A**	**-**	**-**	**-**	**-**
Translation													
Applied Research	N/A	16%	N/A	35%	-	-	-	-	-	-	-	23-100%	-
R&D Collaboration with firms	-	-	-	N/A	-	N/A	N/A	N/A	N/A	-	N/A	14-29%	N/A
Commercialisation	-	-	N/A	-	N/A	N/A	-	-	N/A	N/A	N/A	29%	-
R&D Value Chain	-	-	-	-	-	-	-	-	-	-	-	25-27%	-
Scientific Communication	**-**	**N/A**	**85%**	**-**	**35-43%**	**-**	**-**	**-**	**N/A**	**N/A**	**-**	**33%**	**-**
Total	**30%**	**26%**	**49%**	**27%**	**33%**	**24%**	**29%**	**23%**	**23%**	**31%**	**N/A**	**N/A**	**23%**

Source: Annual Reports of agencies, WIFO calculation. Note: * refers to new applications, 87% for renewals, ** refers to new applications, 83% for extensions. The values partly show a range of success rates of the different funding schemes within a funding category. Data for NWO and UK councils (except EPSRC): 2016.

Table 55: Funding duration of funding schemes according to documents, 2017

Country	**DE**	**AT**	**CH**	**NL**				**UK**					**US**
Agency	*DFG*	*FWF*	*SNSF*	*NWO*	*AHRC*	*BBSRC*	*EPSRC*	*ESRC*	*MRC*	*NERC*	*STFC*	*NIH*	*NSF*
Project funding													
Single project funding (SPF)	3 years	4 years	1-4 years	6 years	5 years	5 years	N/A	N/A	5 years	N/A	N/A	3,6 years*	2,9 years*
SPF Early career	-	6 years	N/A	-	5 years	N/A	N/A	N/A	3 years	-	N/A	5 years	-
SPF high-risk	5 years	-	-	-	-	-	-	-	N/A	-	-	N/A	-
Networks and Multi-Project funding	N/A	-	1-4 years	-	-	N/A	N/A	-	5 years	-	N/A	N/A	-
Interdisciplinary research	-	-	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10 years
Priority areas													
Structural priority area	N/A	8 years	4 years	N/A	-	N/A	N/A	N/A	N/A	N/A	-	-	-
Thematic priority area	6 years	4 years	N/A	N/A	N/A	-	-	-	-	N/A	N/A	-	-
Infrastructure	**N/A**	-	**N/A**	**N/A**	-	**N/A**	-	**N/A**	-	**N/A**	**N/A**	**N/A**	**N/A**
Funding of people													
Education&Training	4,5 years	N/A	N/A	N/A	0.5-2 years	-	N/A	N/A	N/A	-	N/A	N/A	N/A
Career	5-6 years	-	N/A	N/A	0.5-1.5 years	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5 years
Diversification	N/A	3 years	N/A	N/A	-	-	-	-	-	-	-	N/A	N/A
Prizes	N/A	5 years	-	N/A	-	-	-	N/A	-	-	-	-	-
Mobility	2 years	3 years	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	-	-
International Cooperation	**N/A**	**3-4 years**	**N/A**	-	**N/A**	**N/A**	-	**N/A**	**N/A**	-	-	-	-
Translation													
Applied Research	3 years	4 years	N/A	N/A	-	-	-	-	-	-	-	N/A	-
R&D Collaboration with firms	-	-	-	N/A	-	N/A	N/A	N/A	N/A	-	N/A	N/A	Phase 1: 6-12 months Phase 2: 2 years
Commercialisation	-	-	4 years	-	N/A	N/A	-	-	N/A	N/A	N/A	N/A	-
R&D Value Chain	-	-	-	-	-	-	-	-	-	-	-	N/A	-
Scientific Communication	-	**N/A**	**N/A**	-	**N/A**	-	-	-	**N/A**	**N/A**	-	**N/A**	-

Source: Annual Reports and websites of agencies. Note: * average duration.

5. Differences in the grant-based funding of (basic) research: a synthesis

We first provide a systematic review of differences between the DFG and other agencies, before we elaborate on the potential impact of these differences on research outcomes.

5.1 Main structural differences with respect to the DFG

In this sub-section, we provide a focused summary of structural differences between the DFG and the other agencies, based on the findings in section 4. According to the structure of section 4, we start with contextual differences, i.e. differences in the environment in which the grant funding takes place.

Context

Differences in context in which grant funding operates may lead to different impacts of grant funding on research outcomes. Germany's higher education system is a chair-based one, with a lower share of tenured researchers than in systems featuring more department-style systems. Non-tenured researchers may be more risk averse when they apply for grant funding to secure their position. At the same time, grant funding enables early career researchers to pursue their own lines of research, avoiding the limitations of hierarchically structured universities.

To determine the overall amount of incentives set by competitive funding, the share of research grant funding in total (basic) research funding, the level of grant funding relative to the number of researchers and the allocation mechanisms of block funding need to be considered. The share of the DFG's funding – i.e. the share of competitive grant funding - in total HERD is higher than in Austria, similar to the Switzerland and the Netherlands, but (much) lower than in the UK and in the US. Block funding in Germany is not allocated using strict performance-based budgeting according to a recent study, similar to Switzerland, Austria and the Netherlands, but different to the UK.

The DFG's budget is determined on a yearly basis, but currently benefits from the Pact for Research and Innovation which stipulates yearly increases from 2016-2020. The only agency with a multi-year financial framework is the SNSF. The DFG is the only agency which gets is funding based on negotiations between the federal and the state level executive authorities, whereas the Swiss, Austrian and Dutch agencies report only to the federal level Ministry; NIH and NSF request their budgets directly from the legislative body (Congress).

The DFG organises funding activities in a centralised, non-discipline specific way, similar to the SNSF and FWF, leading to an easily accessible funding menu for researchers by comparison with much more complex decentralised or discipline-specific agencies such as NIH or NSF, or by comparison with the 7 UK Research Councils (which at the time of writing still all propose their – albeit fairly similar - own funding schemes). Whether the potential for experimentation or funding scheme diversity is affected by this organisation of funding activities requires more research.

Regarding the mission or focus of the DFG's activities, together with the FWF it is probably least targeting economic or societal impacts which may result of the research it funded, which may be seen in its review criteria (see below) and in its funding portfolio, in terms of thematic focus and translational research, as well as the share of projects funded on the basis of the researchers asking the research questions (curiosity-driven research, bottom-up) vs. solicited research. The DFG is set up as a research funding agency where academic scientists have a formal say in the DFG's principles and funding policies, similar to the SNSF and FWF; the other agencies are governmental agencies with only advisory roles for external academic scientists.

Finally, the "performance" of German academic research, as measured in various ways by citations to it, is below that of the other countries examined in particular regarding universities, except for Austria. This may influence the choice of funding initiatives, e.g. more spending on funding schemes which build research excellence, such as the excellence initiative. By contrast, Germany's good economic and industrial performance (compared with the UK, e.g.) may influence priority setting at the detriment of more economic impact- or translation-related schemes. This is speculative however.

Aggregate funding levels

In terms of aggregate funding levels, the DFG comes relative to population in fourth place above the UK and Austria. Relative to the number of higher education researchers in full time equivalents Germany comes in second, although there are no figures for the US and researchers outside higher education such as in the Max Planck institutes are not covered. In terms of growth of total funding awarded, the DFG achieves the second-lowest growth rate, while the UK grows more dynamically over the period examined. Coming back to the overall amount of

incentives set by competitive funding, this means that all three factors are rather low in Germany, the allocation mechanism for block funding does not feature strong competitive elements, the share of DFG funding relative to block funding is low and the absolute level of DFG funding (relative to population) is also not high. This contrasts with the UK and the US, where almost all of (academic) research funding is peer-reviewed (either ex-ante, through grant funding, or ex-post, through the Research Excellence Framework), and also with Switzerland and the Netherlands, which show high grant funding per population or per researcher in the higher education sector. Only Austria shows even lower competitive funding and hence incentives.

Funding portfolio

Similar to other countries, the DFG's main (single) project funding scheme "Sachbeihilfen" is the most important funding scheme, at about 30% of total. It is lower though than in Switzerland, where the comparable funding scheme is at close to 50%; R01 grants of the US NIH are at 45% of total funding, include however not just bottom-up curiosity-driven research but also some solicited research (see below). Other agencies also show higher shares of their main research grant funding mechanism, they often accommodate however a wider range of proposal types. The share of the DFG's high risk funding scheme is very small, similar to other agencies which feature such schemes. Unlike many other agencies, the DFG does not have a dedicated scheme for funding early career principal investigators, but it does have specific review criteria for them in the standard project funding scheme. Similar to many other agencies, except for the NIH and NSF, the DFG does not have a dedicated scheme for interdisciplinary research only, this is however accommodated or a specific objective in the standard project funding scheme as well as in some network and multi-project funding schemes.

Where the DFG stands out is the high share of structural priority funding, due to its funding of German universities with a view to increase their research excellence. This scheme is different in many ways to what other agencies do, as the universities are funded and not individual researchers requesting funds. It can be explained by the specific German context of the regions providing the base funding for their universities, so that the federal level is limited in reforms to research funding to the grant-based instruments of the DFG.

In terms of change in the shares of funding schemes, the DFG also shows the highest increase for structural priority funding; in line with other agencies, it has also significantly raised the share of spending on research infrastructure, but not on translation, where it features only a small share of funding of clinical trials (however, within the standard research scheme, translational follow-up projects can be proposed, but we don't have data on them). Dedicated schemes for R&D collaboration with firms, or research by small young firms (the SBIR programme for NSF and NIH), or dedicated commercialisation schemes, do not exist within the DFG. Next to very low spending on translational schemes, DFG spending on "people" broadly speaking is also at the low end, with among the main agencies only the NIH spending less (DFG 10% vs. NIH 6%), similar to infrastructure, where it spends about 7% (4-5% in the SNSF and NIH, up to 24% in the NSF).

Overall, the diversity of the DFG funding schemes is quite high, both in terms of the share of the three largest funding schemes as in terms of distinct funding schemes, only behind the NIH (NSF, NWO and UK data are limited for this purpose though). A high diversity enables agencies in principle to try different approaches and choose more effective ones based on evaluation, as well as responding to variety of researchers' needs and characteristics (such as the challenges involved with interdisciplinary funding, support of early career researchers, high risk projects etc.).

In terms of the share of disciplines, the European countries are much more similar than the US, which due to the dominance of the NIH spends relatively much more money on medicine. As the other European agencies, the DFG spends most on natural sciences, although the share has been declining and is lower now than in Switzerland. Medicine is comparable across the European countries at a bit more than 20% (except for Austria), engineering is much higher in Germany than in Austria, Switzerland, the UK or the US. Social sciences and humanities is at a comparable value in the DFG and the UK at around 15%, higher in Switzerland and Austria at above 20% and much lower in the US.

Differences in grant design and characteristics

Concerning the main (single) project funding scheme, the success rate of 30% at the DFG compares favourably with the agencies of the other countries, apart from the SNSF (48%) and some smaller UK Research Councils. However, this is partly due to lower average lot sizes by comparison with most other agencies. The SNSF shows again the highest lot size (with the exception of EPSRC which is however focusing on equipment heavy sciences). By disciplines, the DFG features the highest success rate in engineering, although it aims at rather uniform success rates across disciplines. The standard duration of single projects at the DFG is at the low end with 3 years, similar to the NIH and the NSF, but lower than in Switzerland and Austria (up to 4 years), the UK Councils (up to 5 years) and in the Netherlands (up to 6 years). However, a specific long-term proposal is possible of up to 12 years, and the standard grants can be renewed at a much higher success rate than new grant applications (similar to the NIH, although renewal is even more common there). Given the relatively small size of the DFG in overall research funding of universities and the large role of block funding, which provides long-term research horizons, it is not clear whether enough incentives are set for changing established lines of research (see discussion in section 2).

The DFG, FWF and SNSF single project-funding schemes are generally curiosity-driven, bottom-up schemes and do not feature impact-oriented review criteria (see below, except for use-inspired basic research at the SNSF), by contrast with the other agencies. Switzerland has the highest share of curiosity-driven, bottom-up grant funding (almost 50% of total), while Germany is about 30% and Austria at 43%; the schemes of the other agencies often accommodate a wider range of proposal types or feature strong criteria for economic or societal impact (see next section), or also include some solicited research, as the R01 grants by the NIH, which achieves 45% of total NIH funding.

Regarding cost reimbursement, the DFG pays an overhead rate of 22% (indirect costs as a share of direct costs), slightly higher than the SNSF (20%). NWO and FWF do not pay overheads at all whereas the US federal research grants cover in principle full indirect costs, which differ depending on the research institution from close to 30 to up to 69%; the average is around 50%. The UK follows a different system by paying 80% of full economic costs to the research institutions, including the research time of the principal investigator.

Peer review at the DFG is similar to the other agencies in that if follows a three stage process to ensure overall quality of the review process (first stage – external academic reviewers assess scientific merit, second stage, review boards composed of elected academics review quality of first stage reviews and provide funding recommendation for the third stage, official decision by responsible bodies). Only the NIH always uses panel review in the first stage, i.e. a discussion in person of the reviewers (linked to its study section system), only the NSF does not discuss first stage reviews in a group of different external academic reviewers. Reflecting their academic self-governance, only in the DFG, FWF and the SNSF are second stage reviewers elected by the scientific community rather than chosen by the agency. Reflecting mainly country size, the DFG invites national and international reviewers for the first stage review, while smaller countries such as Switzerland mainly look for reviewers outside of Switzerland or the FWF ask exclusively reviewers from abroad, and the NIH and NSF look for reviewers mainly nationally.

In terms of review criteria, the DFG does not assess non-scientific project merit, such as potential economic or societal impact, or the potential use of the knowledge created outside science, as is the case in all other agencies apart from the FWF; in Switzerland, this is however only the case for self-declared use-inspired basic research projects within the standard single project funding scheme, otherwise the SNSF does also not consider potential impacts in its review criteria. The DFG also features as separate review criteria the suitability of the research and work environment, which otherwise only the NIH asks to assess, and the appropriateness of the funding plan, otherwise only asked by the NSF and the EPSRC. The DFG does not provide explicit weights for its criteria, unlike the UK and the Netherlands.

Finally, the DFG is similar to other agencies in the amount of feedback provided to applicants, the external reviews are to the applicants in case of a negative decision along with additional information on the outcome of group discussions in the second stage. Other agencies also send the relative rating following from second stage prioritisation (SNSF, NIH, NSF). EPSRC and NWO also send first stage reviewer comments to the applicants before the second stage, so that they can respond to the reviewers' comments.

With respect to the overall funding activities of the agencies, the DFG is only similar to the SNSF and FWF in terms of the high or almost exclusive share of both non-discipline specific and bottom-up funding schemes; all other agencies feature high shares of discipline-specific funding schemes (NWO) or are either set up as disciplinary agencies (NIH, UK Research Councils) or organised by discipline (research area, as in the case of the NSF). The

share of funding schemes where research is solicited by the agencies (top-down) can only be approximated in some cases, but using the shares from (single) project funding reported above, the share is considerable. Note that this applies mostly for project funding, while for career, mobility, infrastructure and translational schemes the question of who asks the research question is less relevant.

Finally, the data situation for other funding schemes is highly uneven across the agencies; the DFG provides as an example only success rates for standard single project funding, whereas the NIH provides success rates for a large number of detailed funding schemes.

5.2 Potential impact of differences in grant funding on research outcomes

We mostly focus on differences in the way standard (single) principal investigator grants are allocated, as this is also the focus of the literature and simply because of the limited budget of this study. Differences in career funding schemes, or infrastructure funding schemes, and their likely impact on research outcomes and productivity of researchers, require more research.

First, there is a dearth of good causal relationships in the literature, and what there is, is often focused on the US (biomedical research). This means that any linking of differences between the basic research grant funding agencies to differences in research outcomes, as in quality, quantity or direction, or productivity of researchers, is often only speculative.

Second, a basic condition for any impact to arise is that money is actually spent. The information on the diversity of funding portfolios is hence a first indication of the potential impact of differences. Noteworthy differences, bearing in mind differences in the funding landscape of the various countries and difficulties in fully capturing funding portfolios, include among others

- How comprehensively supply and training of young researchers is addressed – e.g. already at the secondary school level, as in the case of the NSF which funds programmes to stimulate interest in S&T studies vs. only at later stages, e.g. funding for PhD training, as is the case for many other agencies
- How far funding stretches from basic research into more applied research and even funding of commercialisation and prototyping, or how much agencies focus on "translation"; half of NIH spending, e.g., goes into applied research. Funding a "value chain" from basic research to more applied research and then applications is however easier in biomedical research, where applications are much closer to basic science than in other fields, and clinical trials are necessary for drug development. But there are many other examples, as in dedicated commercialisation schemes by Swiss and UK agencies, and the well-known US cross-agency SBIR programme which funds young innovative firms
- How research topics are addressed – purely driven by scientists' curiosity, or also by economic and societal challenges, or by the perceived need to stay competitive in emerging scientific fields; challenge-oriented funding is much lower in the DFG, FWF and the SNSF by comparison with the other agencies.
- How perceived problems in scientific performance are addressed – through larger-scale dedicated programmes addressed at the institutional level, or simply by providing more money for curiosity-driven bottom-up single project schemes; e.g., the DFG pursues the excellence initiative, whereas the NIH has implemented specific high risk funding schemes
- How the difficulties of early career researchers or interdisciplinary research proposals are addressed, either through dedicated schemes (early career: SNSF, FWF, UK Councils) or through specific review criteria or panels (early career: e.g. DFG, interdisciplinary: e.g. UK Councils)

Most agencies have increased relative spending on infrastructure and translation over the past 20 years. Whether this is due to demands for higher economic impact from research funding in the case of translation, or due to disproportionately rising costs of research infrastructure, requires further research.

Third, the overall funding levels of the agencies need to be seen in context with the rest of the funding landscape in the various countries, as well as in context with success rates and hence the number of applications. But generally, the overall share of competitively allocated funding in total (basic) research funding should generate an impact on "quality". Linked to the details of grant funding (such as reimbursement of indirect costs and salaries), there are however also cautionary tales in the form of too much competition leading to risk aversion (influenced though by low success rates). Competitive funding in both grant funding and block funding is particularly high in the UK, US academic research is mainly funded through competitive grant funding, while the Swiss SNSF has

also very high funding per capita, although Swiss block funding is large and formally not allocated on a competitive basis. Competitive funding in the Netherlands is also very high per higher education researcher. Success rates in Switzerland are high despite a high relative number of applications and in spite of a high average lot size.

Fourth, as discussed in section 2, success rates are clearly influencing the way research is done, and may hence also influence research outcomes. Low success rates are certainly bad for the productivity of researchers and reduce the attractiveness of research institutions in countries faced with low success rates; they may lead to risk-aversion of researchers, in particular in combination with the employment situation of the researcher (whether she is on a fixed-term or permanent contract). Success rates are all the more binding as the share of grant funding in total funding is high, as in the US. It remains to be seen how continuously low success rates at the NSF and NIH in the US will impact on the US research system. This also depends on the availability of other funding sources; in Europe, e.g., success rates at the ERC are even lower, but researchers can still turn to national-level research funders.

Fifth, it seems to be easier to influence the quantity and direction of research than the quality of research. There are major differences between countries in the thematic context in which research proposals are submitted, between purely bottom-up, curiosity-driven, to researcher-initiated within pre-defined fields to solicited research, where agencies basically initiate the research. In countries with a higher thematic orientation (be it through discipline-specific funding, solicited research in single project funding or thematic priority areas) we expect a corresponding impact on quantity and direction. E.g., the US should have a much larger share in medicine-related articles than Germany – controlling for size – this can of course be empirically tested but is outside the scope of our study.

More fundamentally, the issue of discipline-specific, thematically-oriented, solicited vs. curiosity-driven research also affects how the "social contract of science" is implemented, with the scientific community deciding mainly by itself what to focus on or with outside (governmental, societal) influence on the choice of research topic. There is barely any systematic evidence on the impact on research outcomes, including on the question on whether there is a trade-off between "quality and direction". This is also reflected in the different governance models of the agencies, from a stronger role of the scientific community to more agency (and hence government-)-controlled policies to differences in the peer review criteria, whether only assessing the science (Germany and Austria, a bit less Switzerland) or also the potential usefulness of the scientific advance for areas outside science, such as grand challenges or economic impacts (all the other countries). So far, the much stronger impact-oriented review system in the US, the UK and the Netherlands, as well as the stronger focus on thematic framing in various sorts, does not seem to have negatively affected the "quality" of the research produced from a relative perspective, judging by Germany's or Austria's scientific performance compared to the others (see section 4.1.4). However, as stressed several times, research performance does not just follow from competitive grant funding, but reflects a wide array of factors, including research organisation and careers, as well as the overall set up of the higher education system. At the same time, it is also not clear whether more impact- and issues-driven competitive grant funding does achieve more benefits for society and the economy. This is a clear case for further research.

Sixth, more research is necessary to formulate hypotheses on any impact from differences in the way peer review is organised, e.g. as regards mail vs. panel review, which type of reviewer to invite for the first and second stage of the review process, whether applicants should be able to respond to reviewers' comments before the second stage of the review, etc. However, the way peer review is done may matter less for research outcomes than funding levels, success rates, using a diversified range of funding schemes able to address various challenges in grant funding (such as interdisciplinary research, or early career researchers), etc.

Seventh, with respect to the funding duration of grants, while the data is not perfect, there seem to be considerable differences between the US, Germany on one side (with 3 years; although Germany also has schemes up to 12 years) and the Netherlands at 6 years, with many others at 5 years. These differences are however partly compensated by the different modalities on the renewability of grants, which is not possible in the Netherlands but frequent at the NIH and also at the DFG. Renewals also feature higher success rates at these agencies. Longer-term research horizons may foster risk-taking and lead to more breakthrough science; however, they may also foster specialisation in specific research strategies and discourage changing to new research lines. Renewability may also act together with large lot size to provide continuous competitive funding of larger research groups. This requires further research.

Eight, a fundamental difference between the agencies lies with indirect cost reimbursement and the refundability of the wages of principal investigators. Full indirect cost reimbursement and partial or total refundability of PI

wages can dynamize the scientific enterprise in a country, through more dynamic scientific labour markets and faster growth/differentiation of science, provided that funding by agencies keeps increasing, otherwise "hypercompetition" may result, in particular when non-tenured researchers are entirely funded by grants, rather than when tenured researchers buy out their teaching time or have their research time covered by a grant. This links to a widespread worry that the growth of science, or more precisely of the number of researchers, is exponential and hence asks for continually rising research funding budgets. However, nominal GDP also follows an exponential growth path and simply increasing research funding every year in the same magnitude as nominal GDP (e.g., by 3,5-4% - 2% inflation and 1,5-2% growth) would not increase the overall weight of research funding in overall spending. Such a base-level growth path could also inform multi-year financial frameworks for the agencies which specify yearly growth rates over several years. This would make it easier for research institutions and researchers to plan their future activities and to be cautious with the amount of new researchers entering academic research. Many detailed suggestions have been made for the US situation, discussed in section 2 which can also be discussed in the EU context, should European agencies decide to switch to a US-style model of full indirect cost reimbursement and refundability of the wages of principal investigators.

Moreover, the number of researchers does not grow at an arbitrary rate (on the contrary, the EU worries about not producing enough researchers to meet its goals of higher R&D intensity). It is influenced by population growth (which in some countries is even falling), and strict training demands in PhD studies. Most countries welcome inflows from abroad, but these inflows may also lead to growing numbers of researchers; such problems are best addressed by supporting brain circulation or helping weaker research systems catching up to the stronger research systems. Researchers in universities can also decide to assume stronger teaching roles should their scientific productivity decline.

As an overall take-away, due to the uncertainties as to what is "best", agencies may pursue a diversified funding portfolio to provide opportunities for early career researchers, interdisciplinary research, high-risk research, mission-oriented research etc. Of course, this depends also on the overall size of the budget of an agency, as overly small funding schemes can be inefficient, beyond being too small to create an impact. The evidence shows that most of the agencies are diversified to some extent, but that e.g. special single project funding taking account of risk, early career etc. are usually very small compared with the main programme.

5.3 Discussion points for the DFG

From sections 5.1 and 5.2, we present some discussion points for the DFG's activities.

- The DFG's funding per capita is relatively small, as well as the DFG's share in total higher education research funding. Together with block funding which in a recent study (see section 4) was assessed as not being strongly performance-based, the amount of competitive incentives provided by research funding is at the low end of the six countries compared (except for Austria). Multi-year financial frameworks (stable growth paths for the DFG budgets) could stabilise expectations and sustainably grow the research enterprise.
- The funding portfolio is diversified, and the standard research project funding scheme "Sachbeihilfen" is actually quite flexible in terms of accommodation proposals of different time horizons, first-time applicants, interdisciplinary research etc. The DFG funds very little "translational" activities in the broad sense used throughout this study, or basic research with a thematic focus. The effect depends to some extent of course on the wider research and innovation system, on other agencies' funding of translational schemes. However, funding various tasks through one organisation and using its review criteria and quality selection system may create different effects than using different agencies, with varying project selection criteria. In Norway and in the UK, research and innovation funding has been merged within one agency. Funding for "people" is also at the low end of the agencies studied, although there are overlaps with the project funding schemes.
- Success rates in the standard project funding scheme compare favourably with most other agencies, but may partly be due to smaller lot sizes and a lower number of applications relative to the number of researchers. Smaller lot sizes and lower funding duration at the DFG may be compensated however by the possibility to renew projects, which is done quite frequently. Moreover, small lot sizes are according to the literature not necessarily bad for research outcomes.

- The DFG does not reimburse the full indirect cost of projects and the wages of (tenured) principal investigators. This could dynamize the scientific labour market, conditional on safeguards against an unsustainable growth of researchers. It could be understood as a "micro-level" complement to the institutional-level excellence initiative, as it would greatly increase the room for strategic university behaviour, facilitating taking up new lines of research and recruiting talent whenever it is available, rather than as a function of medium-term university funding plans.
- The DFG review criteria only look at scientific merit and not at potential non-scientific use of the research results. A response to reviewers' comments after the first stage of the review is not possible.
- Most of the DFG's research funding is for bottom-up, curiosity-driven research (or "excellence"-driven research). Funding research with a specific view to tackling societal challenges, or with a view to economic impact, is less anchored in the DFG's mission than in other agencies and is also less visible in the funding portfolio.

6. Conclusions

Using a structured systematic comparative approach, this study has aimed at finding and analysing differences in (basic) research grant funding between the main science agencies of five countries. The results relate to the context in which agencies operate, to aggregate funding levels, funding portfolios and differences in grant design, characteristics and peer review. In more detail, data on what agencies spend money on, and how they spend it, have been established which allow for a comparison of the relative size of funding schemes in total funding, success rates, lot sizes, funding duration and the share of discipline-specific and curiosity-driven vs. solicited grant funding schemes. On a more qualitative note, peer review criteria and cost reimbursement modalities were compared, as well as decision or governance structures of the agencies which are linked to their funding policies. The organisation of funding activities was discussed with a view to show the various ways in which research funding objectives can be achieved, e.g. through setting up dedicated funding schemes or through making standard research grants flexible by providing among others a variety of review criteria.

Some interesting differences can e.g. be seen in spending levels per capita/researcher, which differ by a factor of 3 between the bottom and the top agency with respect to funding levels. The same holds true for the share of the agencies' funding in total research performed in the higher education sector, which varies between 8 and 55%, implicating significant differences in the way research is conducted.

Grant success rates range from almost 1 in 2 proposals granted to less than 1 in 5, again considerably affecting the research enterprise. Funding durations vary between 3 to 6 years (and in specific cases even up to 12 years), although these differences are partly mediated by the different policies on grant renewal, which is quite common in some agencies and not possible at all in others.

Most agencies have a broad range of funding schemes addressing the funding of research projects, careers or people and infrastructure. Differences are much more pronounced with respect to "translational" schemes, including applied research, R&D collaboration with firms, commercialisation, clinical trials, and more comprehensive approaches spanning basic research all the way to development of applications. Not all of the agencies funding goes into basic research – this ranges from 50% basic and 50% applied to almost exclusively basic, also dependent on the national research funding systems.

Some agencies have a dedicated mission to produce economic and societal impacts and will fund schemes accordingly (e.g., with a thematic focus on challenges) and review projects including non-scientific review criteria, such as knowledge use or potential non-scientific impact; they feature large shares of solicited research of up to 40% in standard research grant funding schemes, while other agencies place much less emphasis on non-scientific impacts and almost exclusively use scientific merit to assess projects which are almost exclusively investigator-initiated or bottom-up projects. This is also linked to the governance of agencies, with some giving scientists a formal say in establishing principles and policies, closer to academic self-governance, while others are governmental agencies using scientists as external advisers.

The reimbursement of indirect costs and the wages of (tenured) principal investigators is also an area of strong differences across agencies. Some are not paying any overhead rate, while others grant full reimbursement of indirect costs. Similarly, some agencies are not paying wages of the principal investigators, while others allow for either a teaching replacement or buying out research time.

While many insights have been gained, there are important limitations to bear in mind, which can also inform future research. There are still few papers allowing to draw causal links between differences in grant funding and research outcomes, so that the potential impact of differences remains sometimes speculative. More investigation of the relationship between funding characteristics and outcome variables, beyond the amount of funding, is necessary. E.g., do review criteria emphasising non-scientific impact lead to different projects being chosen? Are success rates of early career researchers similar to established researchers when there are specific review criteria for first-time applicants? How to analyse the impact of success rates? When success rates are low, they may lead to risk aversion, but also to a smaller share of projects being funded. Conditional on a working review process that would imply higher quality research outcomes – if a simple bibliometric analysis is done of projects funded when success rates are low, it would probably show that success rates are good for "quality".

Moreover, assessing the funding portfolio of agencies, or how much money they spend on different purposes or on objectives, is more difficult than investigating structural differences in grant design and characteristics (such as success rates or peer review criteria). This is not only due to the differences in data availability by the agencies,

although these are considerable: some agencies simply do not track their spending at the level of detailed funding schemes which would be necessary to gain a full picture of funding portfolios. The NIH is probably providing most detail, followed by the SNSF, FWF and the DFG; the NSF provides good funding data at the level of US states and institutions, by broad funding category and by discipline, but not by mechanism (standard grant vs. other mechanisms) nor by detailed funding scheme (e.g., a thematic call within the biological sciences). The UK Research Councils also provide limited data on the detail of their funding schemes to the public, but do have a research projects database which provides a look at the micro-level (so, the UK Councils provide information at the "macro" and a the "micro" level, but the funding scheme-"meso" level is missing). The NWO is most limited in the data it can provide.

A full picture of funding portfolios would be difficult to gain even if all funding data at the level of schemes were present, as there are different ways to address funding objectives, such as funding through dedicated schemes, or providing special review criteria for specific objectives in the standard project funding schemes.

Building a comprehensive funding portfolio would need to start from "micro-data", i.e. from the individual projects funded which are classified according to the characteristics which we used in section 3, such as number of investigators, solicited or bottom-up, interdisciplinary or single-discipline, in response to a thematic call or not, etc. Of course, this would mean a significant change in the way agencies collect data on their activities, although some agencies already have public project-level databases (however without the necessary information), such as the UK and the NIH.

Finally, this study has focused on the main project funding scheme of the agencies, due to the limited budget. With more funding available, other schemes such as career and infrastructure, or translation, could also be compared in much more detail, in terms of grant design and other features.

7. References

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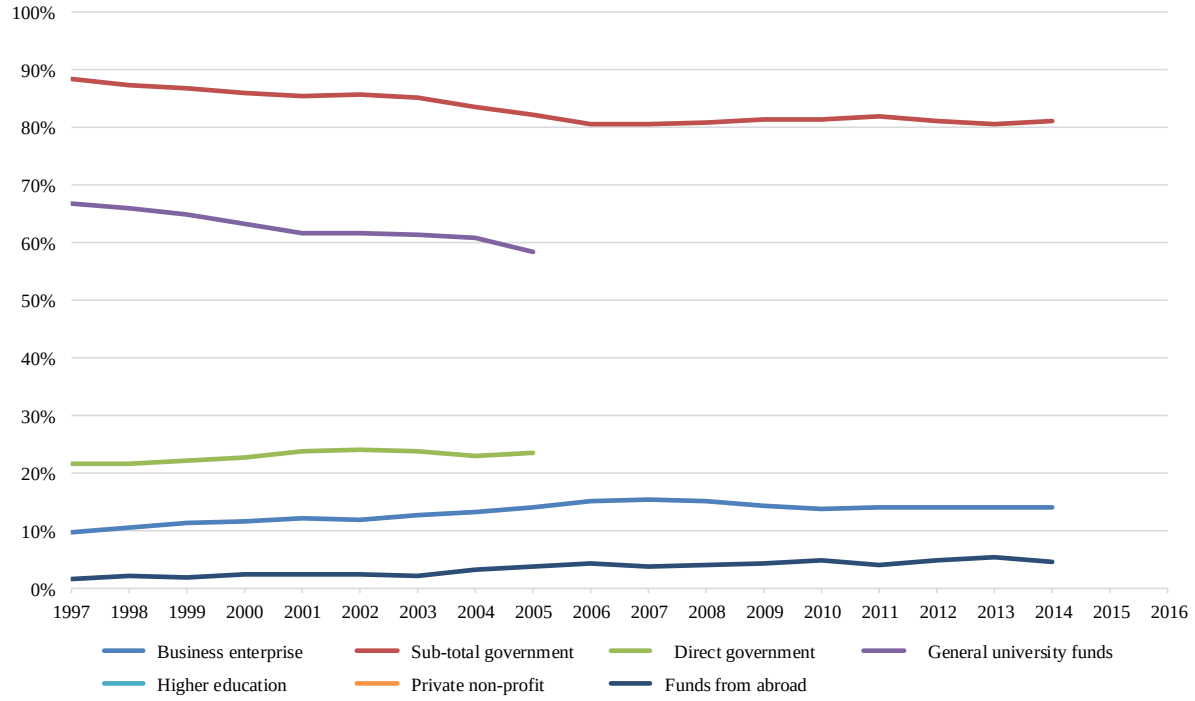
8. Annex

8.1 Contacts at science agencies

See sections on agencies in section 3.

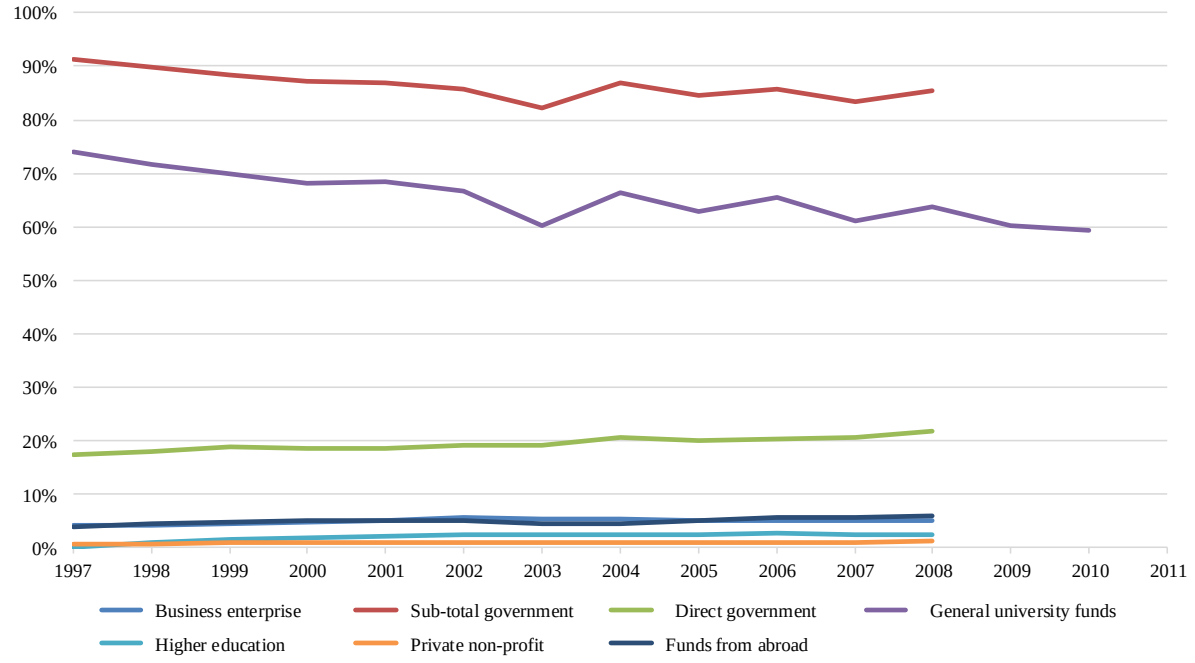
8.2 Additional data: Funding sources of HERD over time

Figure 52: Share of funding sources of HERD, Germany



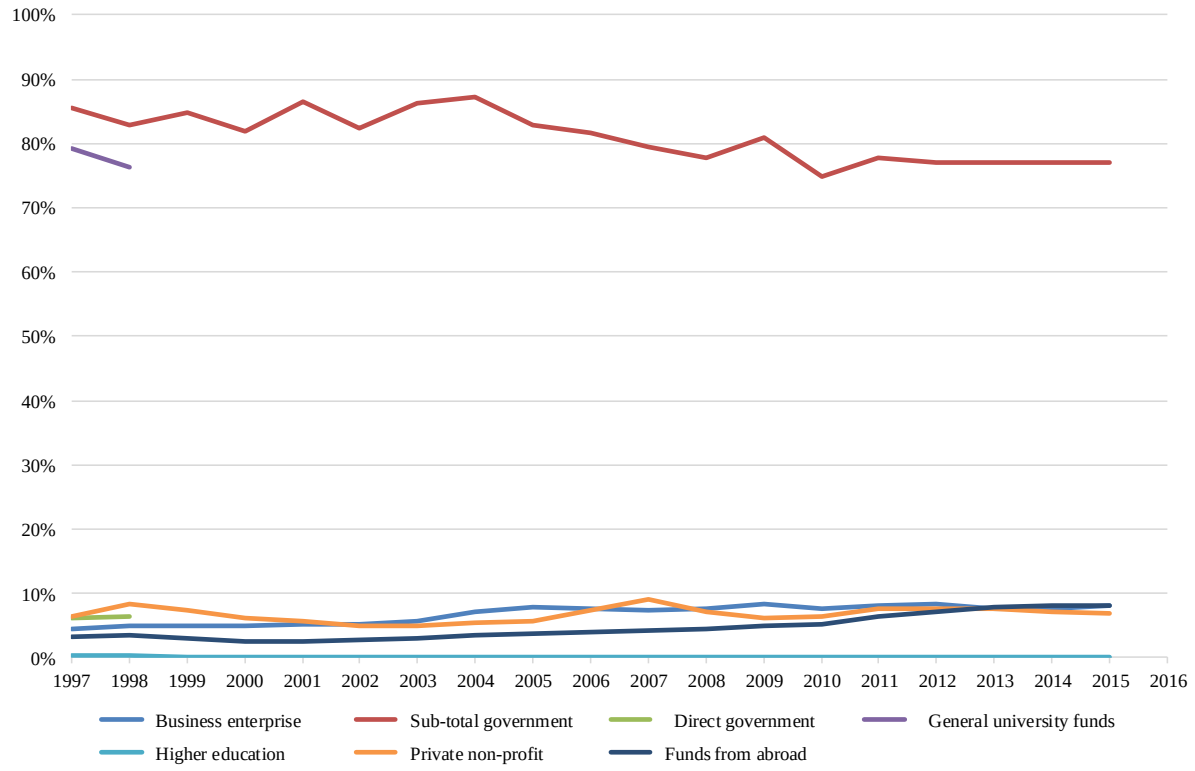
Source: OECD R&D Statistics, https://stats.oecd.org/BrandedView.aspx?oecd_bv_id=strd-data-en&doi=data-00189-en.

Figure 53: Share of funding sources of HERD, Austria



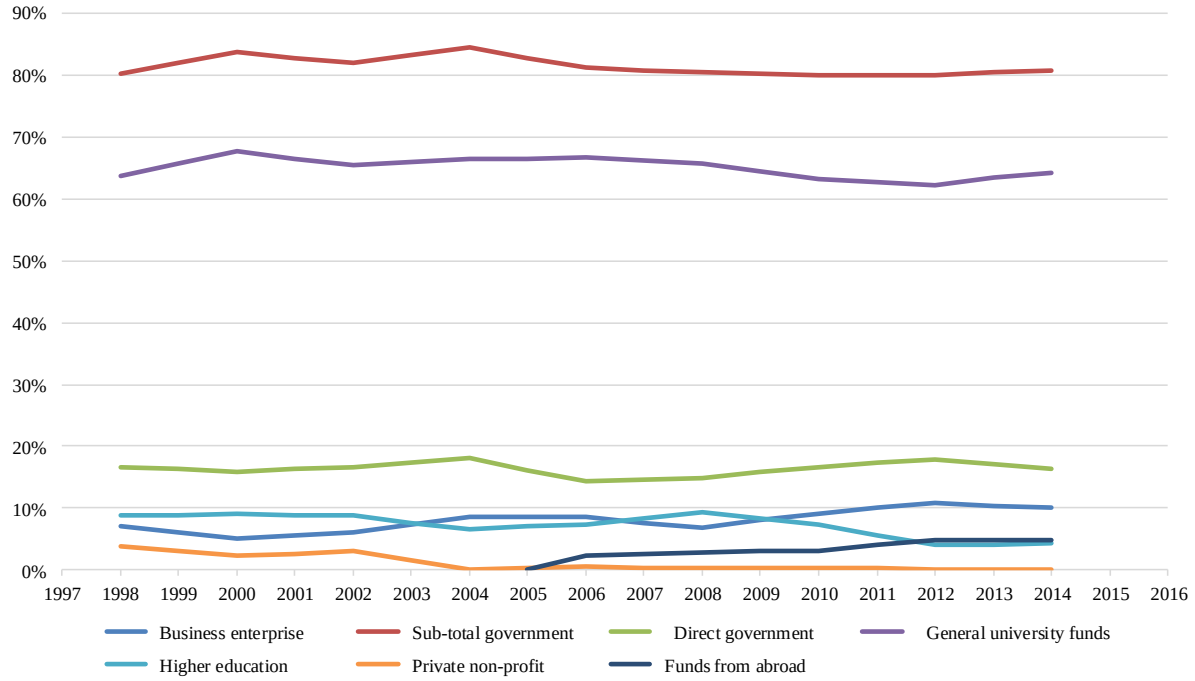
Source: OECD R&D Statistics, https://stats.oecd.org/BrandedView.aspx?oecd_bv_id=strd-data-en&doi=data-00189-en.

Figure 54: Share of funding sources of HERD, Netherlands



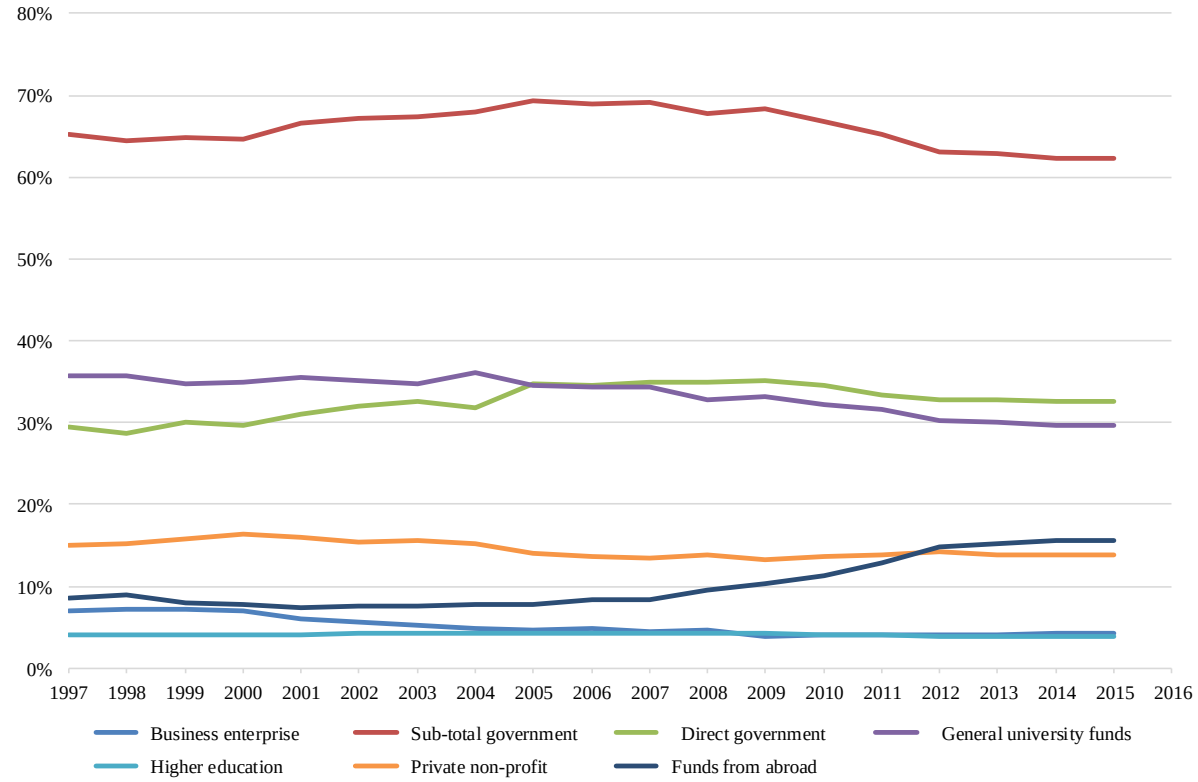
Source: OECD R&D Statistics, https://stats.oecd.org/BrandedView.aspx?oecd_bv_id=strd-data-en&doi=data-00189-en.

Figure 55: Share of funding sources of HERD, Switzerland



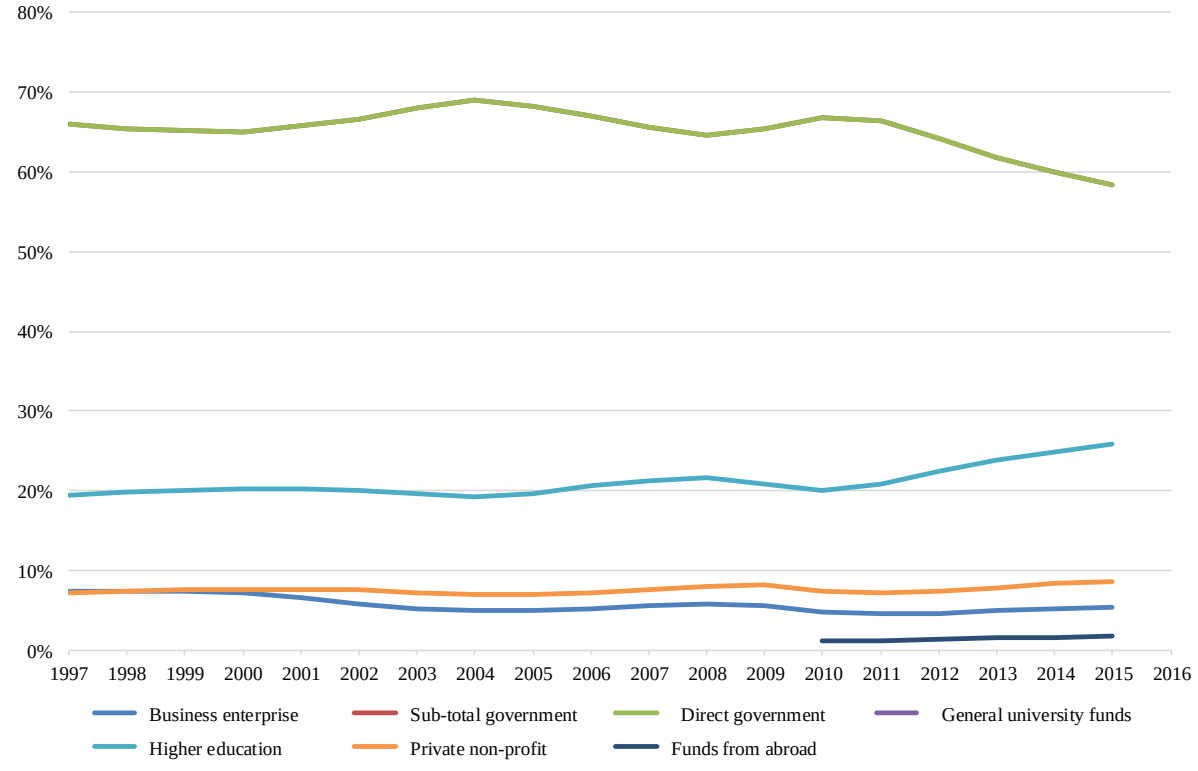
Source: OECD R&D Statistics, https://stats.oecd.org/BrandedView.aspx?oecd_bv_id=strd-data-en&doi=data-00189-en.

Figure 56: Share of funding sources of HERD, United Kingdom



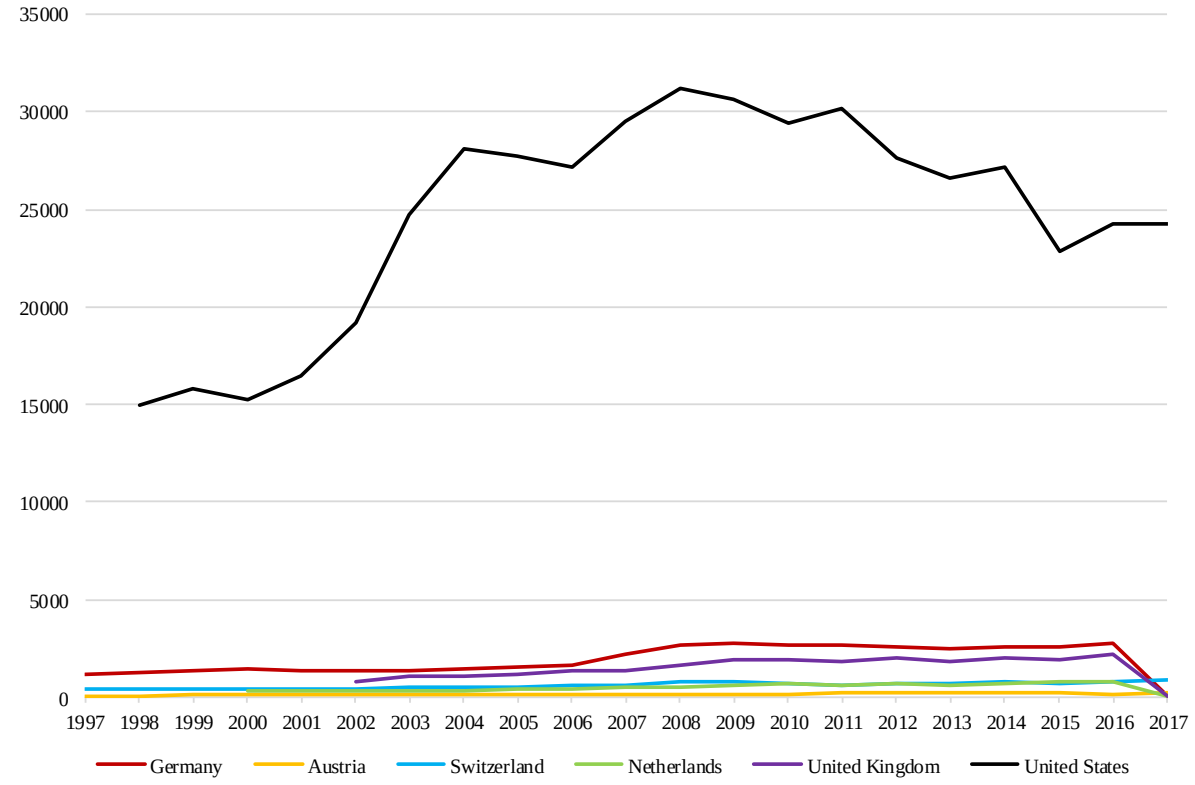
Source: OECD R&D Statistics, https://stats.oecd.org/BrandedView.aspx?oecd_bv_id=strd-data-en&doi=data-00189-en.

Figure 57: Share of funding sources of HERD, United States



Source: OECD R&D Statistics, https://stats.oecd.org/BrandedView.aspx?oecd_bv_id=strd-data-en&doi=data-00189-en.

Figure 58: Total yearly funding by basic research agencies, constant prices



Source: Annual Reports of agencies, AMECO, WIFO calculation.