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August 2022

Organisational and process review of the Human Frontier Science Program

Final report

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Executive summary

This report presents the findings of the Organisational and Process Review of the Human Frontier Science Program (HFSP). Our headline finding is that the HFSP is in good health. It is broadly doing the right things and doing them well. Our headline recommendation is that there is a clear case for the HFSP to grow, both in terms of its overall budget and its human resources. However, in light of the importance of maintaining its unique culture (see below), such growth needs to be gradual rather than sudden.

The HFSP adds value to individual countries' funding landscapes, but the exact type of added value varies by country: for some, the emphasis on basic science is especially valuable, for others the emphasis on frontier or interdisciplinary research, the provision of fellowships or the element of international exchange. At an aggregate, global level, no single characteristic of the HFSP is unique, but we have not been able to identify other schemes that combine the above factors to the extent that the HFSP does.

We find no major difficulties in the HFSP's processes that would be in severe need of repair: participants in our study consistently rate the organisation and effectiveness of most HFSP process aspects very highly. The secretariat staff are praised especially strongly.

Most importantly, the HFSP application assessment processes largely succeed in identifying the most innovative, 'frontier' research ideas and recommend them for funding. The HFSP has succeeded in this respect through creating and maintaining a cultural understanding of what the HFSP is trying to achieve. This 'HFSP-culture' ensures that the HFSP's decision-making is genuinely different from that of mainstream research funding processes, even though the HFSP's processes themselves are very similar to those of many national funders.

Relying on culture rather than process structure to foster a special 'type' of research also allows for a degree of flexibility with the various HFSP aims (i.e. to fund 'frontier' research, novel interdisciplinary perspectives, novel collaborations and international exchange). This helps to avoid these different aims coming excessively into conflict with each other, as they might do if they were overly prescribed and formalised.

We identify two core challenges for the HFSP. Firstly, there is high demand: the HFSP's application success rates are very low, especially when we factor in the Letter of Intent (LoI) stage. This puts substantial pressure on the secretariat and also means that a very small number of the very best research ideas need to be selected from a large pool of possibilities. There also appears to be a substantial influx of unsuitable, poor-quality LoIs, which nevertheless need to be processed.

Secondly, there are some issues around diversity. At present, the HFSP is heavily centred on Europe and North America in terms of applicants, awards and committee and mail reviewer composition. Historical inequalities around gender have been lessened considerably, though a degree of inequality of outcome remains specifically for female principal investigators at the LoI stage. There are also some concerns around the range of interdisciplinary approaches the HFSP is able to attract.

Our findings lead us to a small set of concrete recommendations and a further set of more general possible avenues for change. Most notably, we put forward a range of reforms to the LoI stage, we suggest increasing gender and geographical diversity among reviewers and committee members, and encourage more outreach and networking events, especially on a small scale to target new regions and collaboration with new fields of science.

1 Introduction

This report presents the findings of the Organisational and Process Review of the Human Frontier Science Program (HFSP). This review was commissioned by the HFSPO in January 2022 and has been carried out by Technopolis.

1.1 The remit of this review

This study is not an impact evaluation. There has been significant work in recent years to assess the scientific impact of the HFSP, including a full bibliometric review by Science Metrix in 2018, which is available on the HFSP web site alongside various other reports.[1]

Whilst the present study is also a part of the HFSP's wider evaluation culture, it is of a more fundamental nature than recent work to assess its impact: the terms of reference for this study list a range of questions, which divide into two broad domains. First, the appropriateness of HFSP instruments (i.e. the HFSP grants and fellowships); second, the appropriateness of HFSP selection processes, i.e. the decision-making process determining who receives the grants and fellowships.

These are foundational points of investigation, pertaining to the HFSP's overall aims and objectives, and to the execution of those aims. In the simplest terms, this study asks two central strategic questions:

- Is the HFSP doing the right thing?
- Is the HFSP doing it well?

We note that financial aspects around the HFSP are not in scope of our review. In detail, the questions set for this review in these two headline domains are as follows.

Appropriateness of existing instruments/schemes:

- Is the HFSP support through Research Grants and Postdoctoral Fellowships still the appropriate way in the 21st century life sciences to generate the best in frontier science? Are the current HFSP mechanisms still appropriate to attract applications for truly frontier research, that is internationally collaborative, and of a type not normally fundable through national schemes?
- Given the mission of the HFSP, are there other instruments that would serve that purpose in a better way?
- How could the HFSP improve its monitoring to achieve better attribution and acknowledgement of its awards?
- Is HFSP making the most use of the loosely established network of HFSP awardees and alumni to promote its mission and values?
- Life science in the 21st century has changed. Should HFSP adapt its support to reflect the changes in the funding landscape?

Appropriateness of the selection process:

- Is the selection process for Fellowships and Research Grants appropriate for identifying real frontier research?

[1] https://www.hfsp.org/about/strategy/reviews

- What aspect or condition in the application criteria of the current award types could be improved to make the award even more impactful?
- Are application criteria missing that are more suitable to provide diversity and inclusion across the broad spectrum of scientific fields and nationalities that apply for HFSP awards?
- What part or aspect of the current review and selection process could be improved so as to optimise use of resources?
- Based on our current selection process, are there ways we could reduce the potential for subconscious bias in reviewing applications and selecting reviewers that help HFSP?
- Benchmarking HFSP vis-à-vis other support programs and selection processes of current HFSP members.
- Could the balance of reviewers in terms of country vs expertise be improved?

1.2 Method note

Our findings in this report are based on the following method components:

- Analysis of HFSP applications and awards data from 1991 to the present (though the bulk of our analysis focuses on the period from 2002 onwards)
- A review of the HFSP's various strategy and process documents (supplied by HFSPO)
- An online survey of all individuals who have served on any of the HFSP committees (Grants, fellowships or CDA) at any point since 2017 (N=137, n=70, response rate: 51.1%)
- An online survey of individuals who have provided at least two mail reviews for HFSP applications since 2017 OR at least 3 mail reviews since 2010 (N=170, n=69, response rate: 40.6%)
- Interviews with ten individuals at the HFSP secretariat and council of scientists
- A consultation of HFSP supporting parties in the shape of an open call to submit views via email, sent to key individuals at all HFSP supporting parties. We received 16 responses
- A desk review of funding schemes available from the HFSP supporting parties (or, where the supporting party is not itself a funder, then at funders they in turn support)

Full descriptions and aggregate results of these methods are presented in the Appendix sections of this report.

2 Overall good health of the HFSP

Our headline conclusion is that the HFSP is broadly in good health. Both its overall offer of grants and fellowships, and the processes to award these are generally fit for purpose and we found no grounds to suggest major deficiencies or urgent needs for substantial reform.

While we highlight some challenges and areas for reform later in this report, our critical findings need to be seen in this overall positive context. We have opted to highlight the positive aspects of the HFSP in detail here in the early report sections, as they also need to inform any decisions that may be made on reforming the HFSP: any changes made should ensure that the many positive aspects of the programme are not accidentally undermined.

2.1 Relevance and uniqueness of the HFSP offer

Our review has found that the general shape of the HFSP's current offer of awards is appropriate and, in fact, highly appreciated. While this review does not have a focus on impacts/outcomes of HFSP-funded awards, we note that the findings of such work underscore that the HFSP is certainly performing well, e.g. in terms of citation performance of publications, and the number of Nobel laureates who are also HFSP alumni. From our own research, we note the following points:

- There is broad consensus amongst respondents from HFSP supporting parties that the HFSP's offer is useful and important in its current form. Whilst respondents make several suggestions for minor adjustments, none suggest fundamentally altering what the HFSP does
- Similarly, respondents to our surveys of HFSP committee members and mail reviewers frequently made comments about the importance of the HFSP, often noting that no significant changes to the offer are needed
- As we detail later in this report, there is also high demand for HFSP funding, indicating strong relevance to the global scientific community

Aside from general importance and appropriateness, our review of HFSP supporting parties' funding instruments additionally sheds light on the HFSP's uniqueness. We detail our findings in Appendix C. In brief, we can note the following:

- While many programmes in several countries note an ambition to fund frontier research, few make this a central focus of funding activities
- There is a general commitment to frontier research across many of our comparator schemes, though not necessarily as front-and-centre as it is in the HFSP. Commitment to fund interdisciplinary research is however strongly limited to grant-type awards. Of the 65 fellowships reviewed at the supporting parties, only six mention a commitment to interdisciplinary research, so the HFSP fellowships are especially unique in this respect
- Ambitions to fund frontier research and interdisciplinary research sometimes go hand-in-hand in the programmes we reviewed. However, there is far less connection between these aspects and any form of international collaboration and exchange – in fact, there is a slight negative correlation. In other words, programmes seeking to fund frontier and/or interdisciplinary research tend not to include international dimensions

These findings represent an aggregate of 112 programmes across 15 HFSP supporting parties. There are substantial differences depending on national context. For example, in general, the HFSP awards are slightly larger than the average of our comparator programmes, but in some countries the available awards might be substantially larger than the median figures of our comparators.

Most importantly, different aspects of the HFSP offer have different levels of uniqueness depending on country: supported by our interviews, our consultation of supporting parties, as well as the review of supporting parties' programmes, we find significant variation in this respect: some countries appear to have many programmes emphasising 'frontier' research, others do not. Some countries have very little available funding for 'basic' as opposed to applied research, whilst in others there is substantial provision of basic research funding. Provision of funding for postdoctoral fellowships likewise varies substantially among countries, as does provision of funding for international mobility, collaboration and exchange.

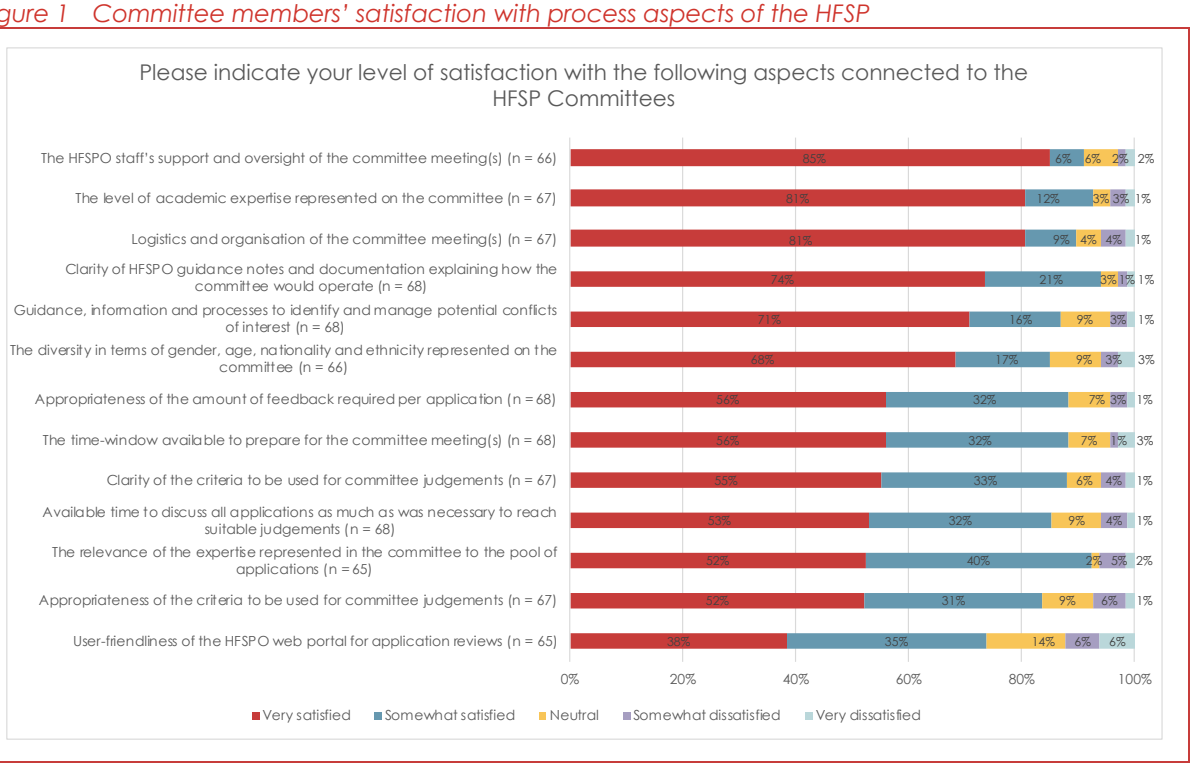
In short, depending on national context, the HFSP is unique and relevant for different reasons. Each of its characteristics (frontier-research, interdisciplinary research, award size, fellowship-focus, international exchange, etc) may carry greater or lesser weight in different places.

At a general level, we also conclude that it is in fact the combination of the HFSP's many aspects that gives it uniqueness across countries: some supporting parties may have programmes for frontier research, others for international exchange, others again may have a strong supply of postdoctoral fellowships, but the combination of all the HFSP's aspects appears to be unique, or at the very least extremely rare.

2.2 Overall verdict on HFSP processes

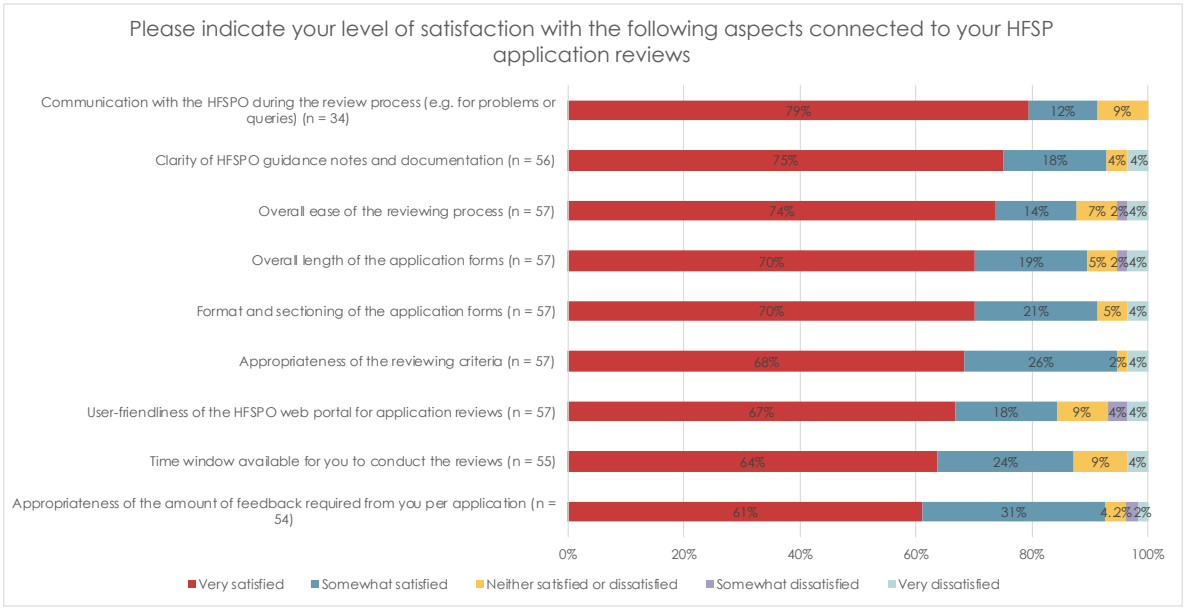
At the process level, we likewise find very few areas of concern overall. We asked HFSP committee members and mail reviewers to note their level of satisfaction with a wide range of aspects connected to the HFSP's processes. Across both groups of respondents and across all aspects we surveyed for, at least 73% of respondents report being either 'very satisfied' or somewhat satisfied'.

Figure 1 Committee members' satisfaction with process aspects of the HFSP



Survey of HFSP Committee Members, Apr 2022. Graph excludes 'Don't know / Not applicable' responses.

Figure 2 Mail reviewers' satisfaction with process aspects of the HFSP



Survey of HFSP External Reviewers, Apr 2022. Graph excludes 'Don't know / Not applicable' responses.

These findings are extremely encouraging and indicate that from the user perspective the HFSP processes are not in any substantial need of reform. We note in particular that the support from HFSP secretariat staff is rated exceptionally highly.

There is only one survey item where more than 10% of respondents voiced some level of dissatisfaction, namely the user-friendliness of the HFSP web portal for application reviews, specifically from the point of view of committee members. Our interviews likewise revealed dissatisfaction with the current system. However, the current system (ProposalCentral) has only been introduced at HFSP very recently. During the lifetime of our review, we understand that several optimisation steps have taken place and further 'teething problems' inherent in any new off-the-shelf system are likely to be ironed out.

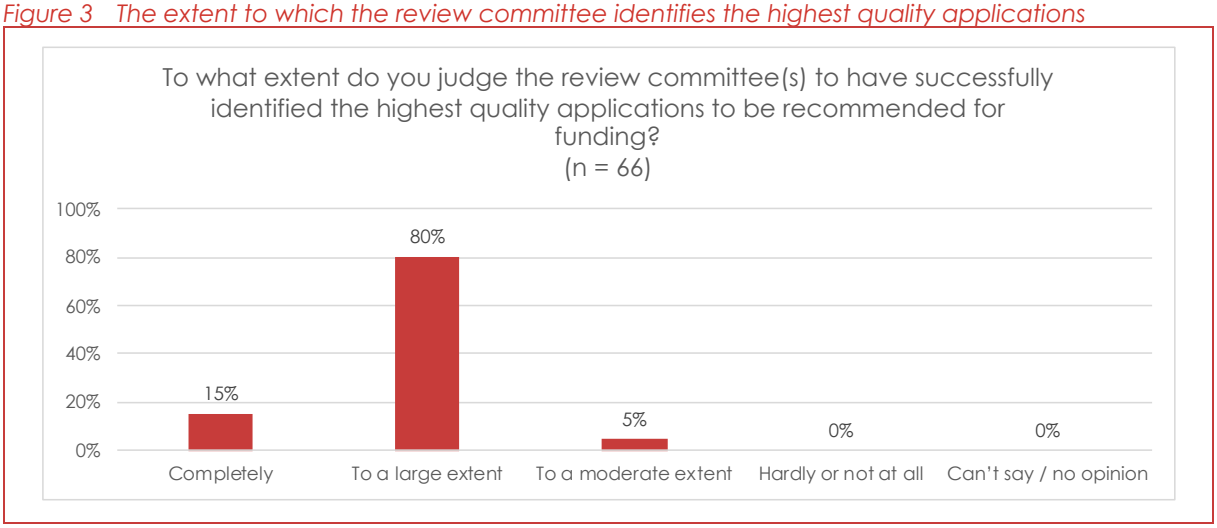
Aside from process satisfaction, we also asked committee members to judge the ultimate success of the HFSP awarding processes. In other words, does the process actually accomplish what it is supposed to?

We surveyed for three aspects, namely whether respondents feel that the committees have successfully identified, respectively, the highest quality applications, the most 'frontier' (i.e. non-conventional, transformative) applications, and the most novel interdisciplinary approaches.

On the former two of these aspects, respondents provide an overall positive verdict. On novel interdisciplinary approaches, respondents are slightly less positive with 30% judging that committees have only been 'moderately' successful in this respect. This in fact reflects some issues we find around the extent of the HFSP's interdisciplinary focus, which we address later in this report.

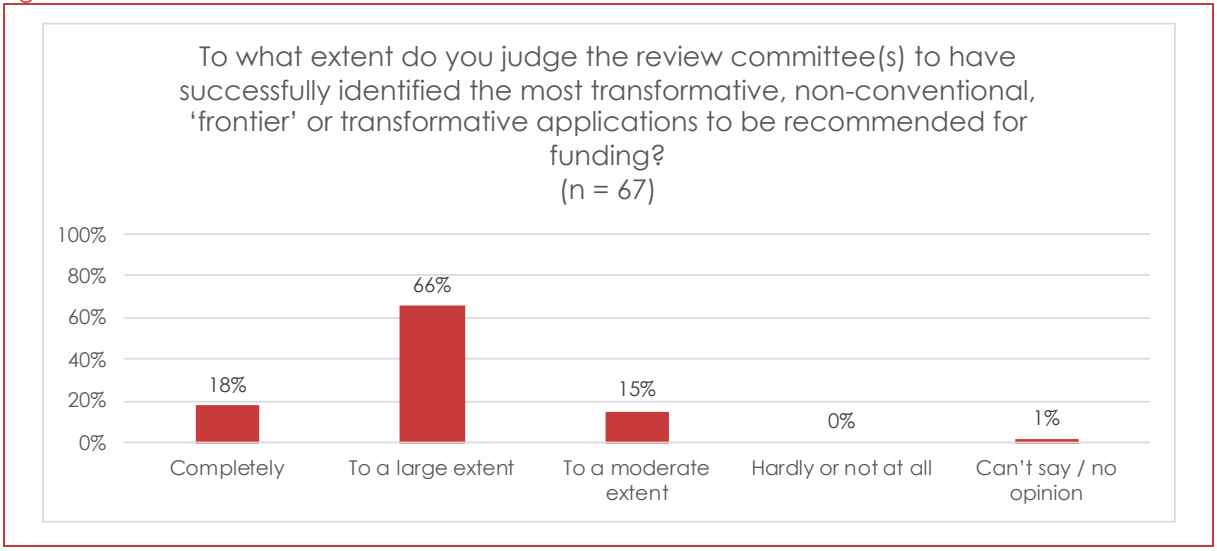
Overall, we find that in addition to the HFSP's offer being widely viewed as appropriate and unique, we also find that its processes are not only operationally healthy, but also considered broadly effective in terms of ensuring that the HFSP funds the kinds of endeavours that it intends.

Figure 3 The extent to which the review committee identifies the highest quality applications



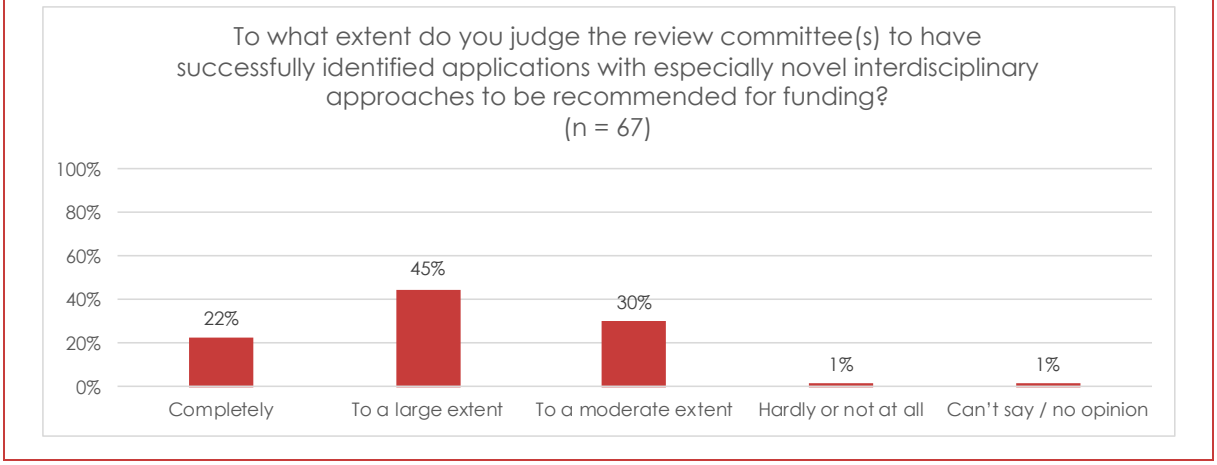
Survey of HFSP Committee Members, Apr 2022.

Figure 4 The extent to which the review committee identifies 'frontier' research



Survey of HFSP Committee Members, Apr 2022.

Figure 5 The extent to which the review committee identifies novel interdisciplinary approaches



Survey of HFSP Committee Members, Apr 2022.

3 Culture over structure: why the HFSP succeeds

The previous section provided a high-level view of the HFSP's general health, both in terms of relevance and process. Before we move to the challenges and problem areas, it is important to also consider *why* the HFSP is successful. Specifically, it is important to understand how the HFSP succeeds in identifying and funding the most non-conventional and potentially path-breaking 'frontier' ideas.

For context, it is worth noting at this point that there is a growing literature highlighting the limitations of peer review, some of which are relevant to the context of the HFSP. The centrality of peer review for research funding is acknowledged as critical for identifying and funding the highest quality science. However, there is increasing recognition that conventional funding processes consisting of remote peer review and panel review (or 'committee' review in the HFSP's case) tend to put especially innovative and 'transformative' ideas at a disadvantage, not least because these tend to entail a higher level of risk.[2] This is especially so in cases of high competition and low overall application success rates – as we note later in this report, this is certainly the case for the HFSP. There is also growing recognition that peer reviewing all applications or relying exclusively on peer review does not necessarily lead to optimal funding outcomes.[3]

To combat these difficulties, many funders who have sought to fund especially path-breaking or 'frontier' research in specific schemes have made significant changes from what might be termed a 'standard' research funding review process. Examples include:

- The UK ESRC's 'Transformative Research' scheme involved (stage 1) a double-blind review of two-page project outlines, and (stage 2) a 'pitch-to-peers' presentation, where applicants successful at stage 1 present their research idea in person to reviewers and fellow applicants
- In the Volkswagen Foundation's 'Experiment!' scheme, the very best applications and the 'tail' of sub-standard ones are agreed on by a review panel, while the remaining awards from the 'mid-field' are allocated by lottery
- For the US NSF's 'Small Grants for Exploratory Research (SGER)', funding decisions were at the discretion of discipline-level programme managers, with no formal peer review

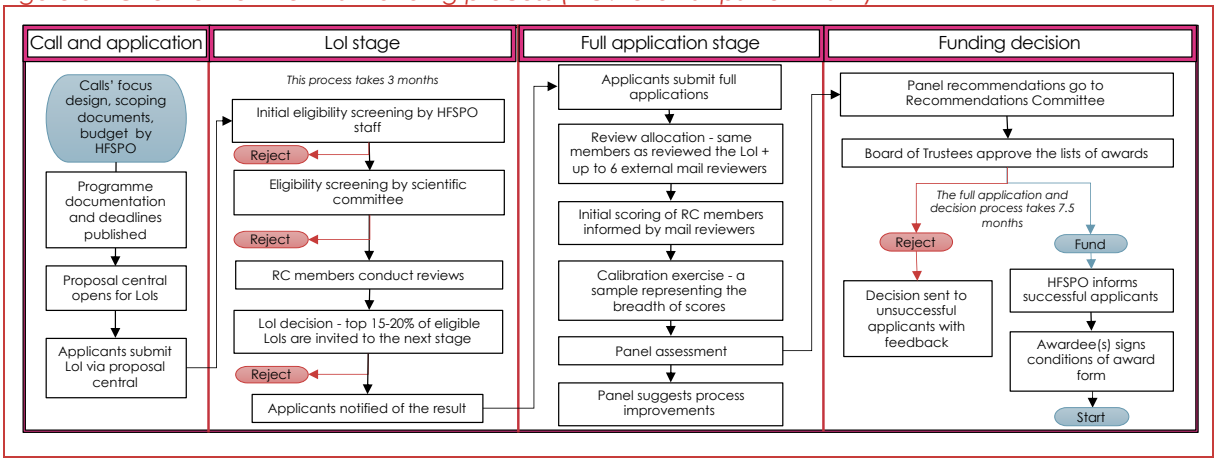
By contrast, the HFSP's application review and decision-making processes are relatively conventional in terms of their structure. Until recently, the HFSP fellowships were awarded through a process consisting of administrative checks, mail reviews and committee review. For grants, there is the additional 'Letter of Intent' (LoI) stage, which is also a common technique used by many other research funders to manage demand and ease the peer review burden

[2] See e.g. Guthrie S., Ghiga I. & Wooding S. (2018). What do we know about grant peer review in the health sciences? [version 2; peer review: 2 approved] F1000Research, 6:1335; Langfeldt, L. (2006). The policy challenges of peer review: managing bias, conflict of interests and interdisciplinary assessments. Research evaluation, 15(1), 31-41; Nuffield Council on Bioethics. (2014). The findings of a series of engagement activities exploring the culture of scientific research in the UK. Nuffield Council on Bioethics.

[3] See e.g. Abdoul, H., Perrey, C., Amiel, P., Tubach, F., Gottot, S., Durand-Zaleski, I., & Alberti, C. (2012). Peer review of grant applications: criteria used and qualitative study of reviewer practices. PLoS One, 7(9), e46054; Clarke, P., Herbert, D., Graves, N., & Barnett, A. G. (2016). A randomized trial of fellowships for early career researchers finds a high reliability in funding decisions. Journal of clinical epidemiology, 69, 147-151; Graves, N., Barnett, A. G., & Clarke, P. (2011). Funding grant proposals for scientific research: retrospective analysis of scores by members of grant review panel. Bmj, 343, d4797; Mutz, R., Bornmann, L., & Daniel, H. D. (2016). Funding decision-making systems: An empirical comparison of continuous and dichotomous approaches based on psychometric theory. Research Evaluation, 25(4), 416-426.

in research funding schemes. Since 2022, the LoI stage is also being used for HFSP fellowships, meaning there is now a standardised process across all HFSP schemes. This process strongly resembles those in use by funders across the globe, including in schemes with no ambition to fund especially path-breaking, interdisciplinary or internationally collaborative awards.

Figure 6 Overview of the HFSP funding process (incl. fellowships from 2022)



Source: Technopolis

In the absence of processes that depart substantially from what may be termed a 'standard' review and awarding process, we would expect to find that committee members and mail reviewers reward and prioritise the same characteristics that they would in other basic research funding programmes (e.g. for their respective national research funders). These are typically centred on rigour, robustness and feasibility of the proposed research, as well as the originality (though not necessarily in a 'frontier' or path-breaking sense) and relevance or importance of the proposed work and topic to the scientific community.

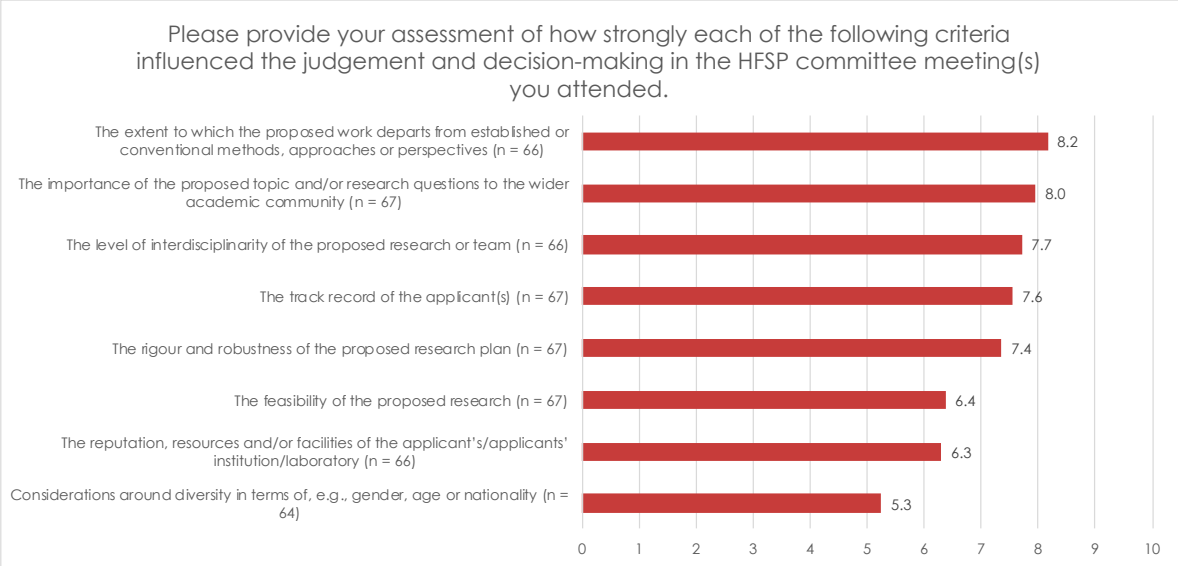
However, we find that the committees appear to focus less on these conventional research funding criteria, and instead prioritise in their judgements precisely those aspects that the HFSP seeks to identify and fund.

We asked respondents to our survey of committee members to rate on a scale from one to ten how much each of a range of different criteria influenced the committees' judgement and decision-making. Our list included both conventional criteria (see above) as well as interdisciplinarity and 'frontier' aspects.

The chart below shows the average scores given by committee members. While several criteria are acknowledged to carry substantial weight, the overall highest-ranked criterion is 'The extent to which the proposed work departs from established or conventional methods, approaches and perspectives' (we use this as a more concrete definition of 'frontier' research), with interdisciplinarity coming in third place. Meanwhile, 'feasibility of the proposed research', while also important, appears to carry far less weight in committee judgements and decision-making, which is firmly in line with the HFSP's ambition to fund un-tested and potentially high-risk endeavours.

These findings are extremely encouraging: standard peer and panel review processes are known to generally favour low-risk, incremental and conventional research. However, the HFSP uses a conventional process but achieves unconventional results with it.

Figure 7 Factors influencing committees' judgements and decision-making



Survey of HFSP Committee Members, Apr 2022. Respondents ranked each criterion on a scale from 1 to 10, where 1 represents 'no influence' and 10 represents 'extremely strong influence. Scores here represent an average of responses. Graph excludes 'Don't know / Not applicable' responses.

Our research finds that the HFSP's operational success is attributable to a culture that has been created over the past decades, where the importance of 'frontier' research and other HFSP aims have been ingrained (and continue to be actively ingrained) across the organisation. In terms of characterising the HFSP, and also in terms of considering reforms, identifying this 'HFSP culture' as a driver of its success is the most critical finding of our study.

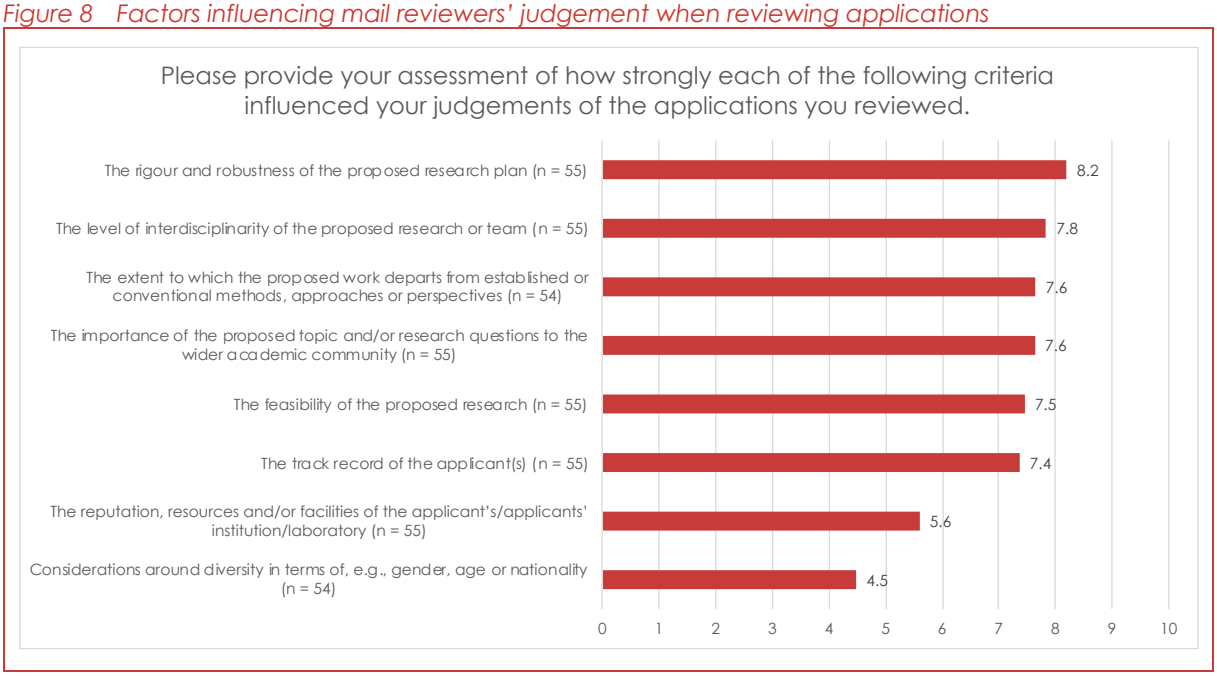
Creating a culture is a complex issue, and not one this review can fully describe in every detail. However, we have identified several components that have contributed to it:

- The origins of the HFSP's culture appear to lie in the 2000s, when the secretary general at the time sought to ensure the committees would be composed of exceptionally experienced and interdisciplinary experts, most likely to understand and operationalise the ambition to fund 'frontier' research
- Since then (and increasingly in recent years), there has been a substantial induction process for new committee members to communicate to them the purpose and emphasis of the HFSP and what the committees should be looking for and rewarding in applications
- The importance of emphasising 'frontier' research and interdisciplinary dimensions are also reiterated in briefings by HFSP secretariat staff at committee meetings
- The secretariat staff have for the most part worked at the HFSP for a very long time (over ten years almost without exception, often much longer) and are therefore very well 'socialised' into the HFSP's mission. We also note that a large portion of the secretariat staff has at least PhD-level expertise in life sciences, meaning they are able to critically engage with the substance of submitted applications
- There is an increasing exchange between HFSP award holders and the organisation of the HFSP: there are HFSP 'alumni' on the committees, the science council and in the secretariat, which likely contributes to an increasingly solidified understanding of what the HFSP is 'about'

These are the main mechanisms through which individuals are 'socialised' into the HFSP culture. This conveys and perpetuates an understanding of what the programme is looking for and how those involved in the judgement and decision-making should therefore behave. This, in short, is why the HFSP works.

We can provide something of a counterpoint to illustrate this further: we asked mail reviewers to rank their judgement criteria in a similar way as we asked the committee members. Mail reviewers by definition are further removed from the programme, and while they also receive some briefing on how to assess proposals, this is far less comprehensive or habitual than it is for individuals more directly involved in the programme. Whilst we find that 'frontier' aspects and interdisciplinarity are also rated highly by mail reviewers, 'rigour and robustness' – a criterion typical of standard basic research funding – is generally judged as the most significant factor influencing mail reviewers' judgements. This may indicate that weaker exposure to the HFSP culture dilutes attention to its objectives.

Figure 8 Factors influencing mail reviewers' judgement when reviewing applications



Survey of HFSP External Reviewers, Apr 2022. Respondents ranked each criterion on a scale from 1 to 10, where 1 represents 'no influence' and 10 represents 'extremely strong influence. Scores here represent an average of responses. Graph excludes 'Don't know / Not applicable' responses.

There is an additional advantage to operationalising the HFSP's aims culturally rather than structurally, namely that it allows for flexibility around how the various criteria are applied. In so doing, this likely helps to avoid different criteria coming into conflict with each other.

The HFSP seeks to accomplish a range of different things within the same funding tools: frontier research, novel interdisciplinary approaches and international exchange and new international collaboration. If each of these criteria had, for example, separate review stages, separate scores, or if each was overly defined and formalised, there would be a strong possibility that, for example, an application strong on three of these criteria would be automatically rejected if it were slightly weaker on the fourth.

Some comments from our study participants suggested that such conflicts do occasionally occur, e.g. where highly path-breaking ideas are not funded because the extent or novelty of international collaboration is not deemed strong enough. However, such instances are rare.

On the other hand, several participants noted that committees and other decision-makers are at liberty to exercise a degree of flexibility when weighing up how an application stands up on the various criteria the HFSP seeks to reward. In fact, there is a widely held view among the secretariat and committee members that 'frontier' dimensions, interdisciplinarity and the extent and novelty of international collaboration are not treated as fully separate criteria, but may instead combine in a wide range of different ways to make an application 'HFSP-worthy'.

Minimum standards need of course to be met, for example on the number of countries or extent of field-diversity. However, if for example the selection of a minimally diverse team (in terms of country or field) can be justified through a particularly innovative research idea which could only be conducted with that particular team, then the application may well be considered for funding rather than being rejected on technicalities.

Given the HFSP's particular ambitions, there is merit to this approach: 'frontier' research is a slippery concept to fully define; interdisciplinarity may be defined, but its extent is hard to quantify or 'measure' beyond some very basic parameters; and given that researchers may often have co-attended conferences, have many mutual acquaintances or co-published one or a small number of papers in the distant past, it is likewise a challenge to fully define at what point a collaboration is 'new'. The HFSP has only partially formalised such definitions, and instead relies on a shared cultural understanding of how the totality of its criteria should be viewed and applied from case to case. This has almost certainly helped the programme avoid excessive fretting and allowed focus on the bigger picture of what the programme is trying to achieve.

3.1 The limitations of culture-driven success

The importance of culture over structure is a critical component of the HFSP, and any reforms need to ensure that the HFSP culture as described above is preserved if it is to continue producing the positive results highlighted in impact assessments over the years. However, it is also critical to be mindful of the potential limitations that come with this approach. In short, while processes can (with additional resources) be expanded and/or replicated, cultures are fragile, and difficult to scale or export to new areas.

This presents a challenge in two main ways. First, there is a need for caution and patience when bringing new personnel into the HFSP, be it at the secretariat, council or committee level (by extension, this may even apply to mail reviewers). New arrivals may need more time to adjust and 'learn' the HFSP culture than might be the case in ordinary funding streams of, for example, national research funders. Additionally, if the HFSP were to be expanded rapidly and significantly, there would likely be an influx of many new individuals not familiar with the HFSP culture, potentially risking dilution of that culture.

Second, significant outreach and communication would be needed when trying to expand the HFSP's reach into new disciplines or regions. As we detail in a subsequent section of this report, there are good reasons to consider such expansion. However, the presence of former HFSP award holders, hosts or committee members in certain countries, institutions or disciplines enables the HFSP culture to be better understood there. Such individuals may even help identify and advise potential new HFSP applications, or indeed to signpost them to the HFSP. Where such individuals are missing 'on the ground', it may be challenging to explain what exactly the HFSP is looking for.

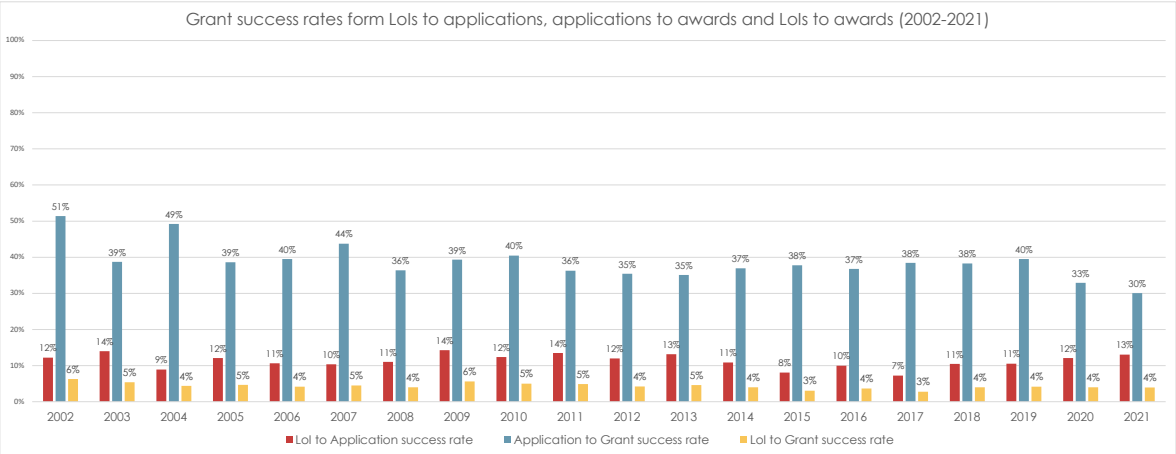
4 Challenge I: High demand in a constrained environment

While our review reaches an overall positive verdict on the HFSP, we find two key areas of potential challenge. We address the first of these in this section, namely the issue of high demand and its consequences. The next main section will deal with the second main challenge, which concerns issues around diversity in terms of region, gender and field.

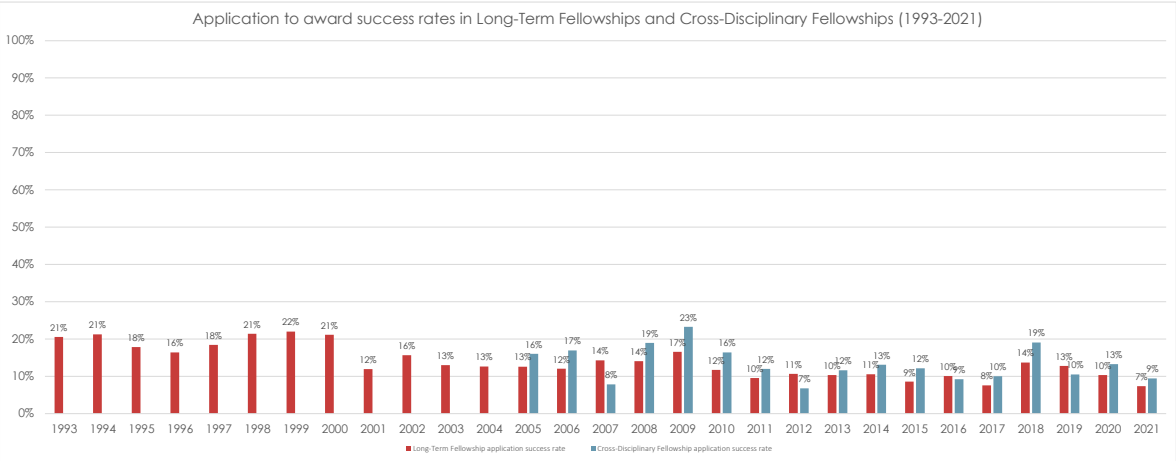
As noted earlier in this report, demand for HFSP funding has remained consistently high over the years, with LoI and application numbers and consequent success rates broadly stable.

Figure 9 Success rates of HFSP LoIs and applications over time

Grants – success rates over time



Fellowships – success rates over time

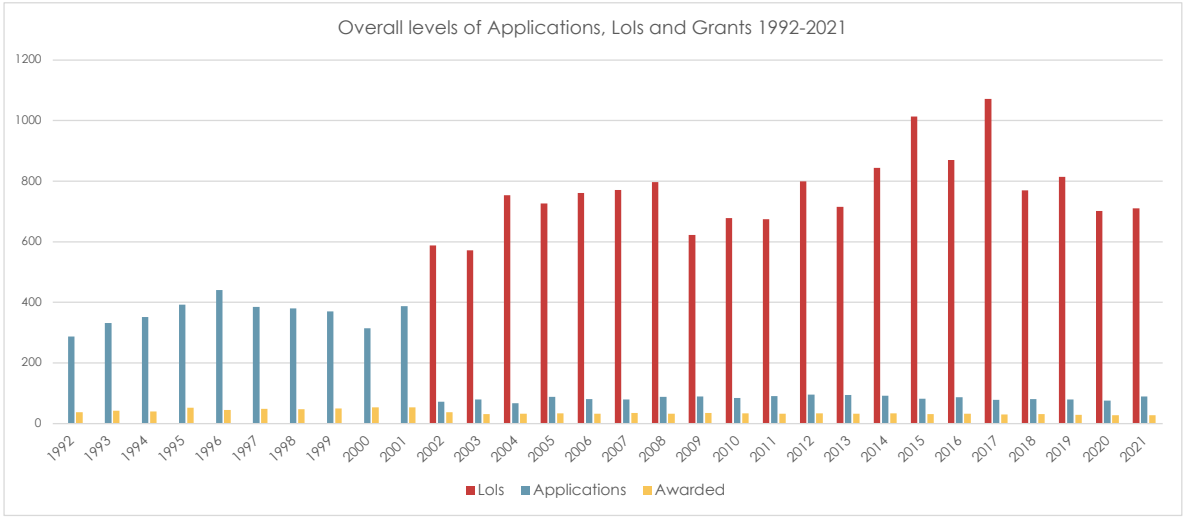


Source: data provided by HFSPO. NB: we exclude pre-2002 data for grants, as these pre-date the introduction of LoIs and are therefore not comparable, though the address the difference made by LoIs below

In the wider context, these application/LoI success rate figures are quite low. Among our 121 comparator schemes, the median application success rate for both grant and fellowship schemes is 20%. This compares to around 8-15% in recent years for HFSP Fellowships and either

4% for grants of LoIs are included or 30-40% if they are not.[4] Application rates have remained broadly stable over the years indicating the relatively low success rates do not necessarily discourage application. However, there is at present a risk that the HFSP will see a rise in applicants. As noted before, the HFSP has recently mainstreamed the use of LoIs across its portfolio, so they are now also in use for fellowships. The experience of the introduction of LoIs for grants in 2001/02 suggests that there may be a substantial increase in applicants. We can of course not predict with certainty that the experience from the HFSP grants will be exactly replicated, but introducing LoIs certainly lowers barriers to entry and may well result in more researchers applying.

Figure 10 Overall numbers of LoIs and Applications for HFSP Grants 1992-2021



Source: data provided by HFSPO

In our understanding, the LoIs have been introduced to the fellowships in part to have the same process structure for all HFSP funding. However, there is also an issue around managing review burden: given the relatively lengthy full applications and the high demand (evidenced by the low success rates), there is a large amount of reviewing to be conducted by committee members and mail reviewers. The experience from HFSP grants is that the introduction of LoIs leads to a substantial reduction of full applications to be reviewed. At the full application stage, there is therefore a reduced burden. However, it also leads to an overall higher influx of applicants at the start of the application process.

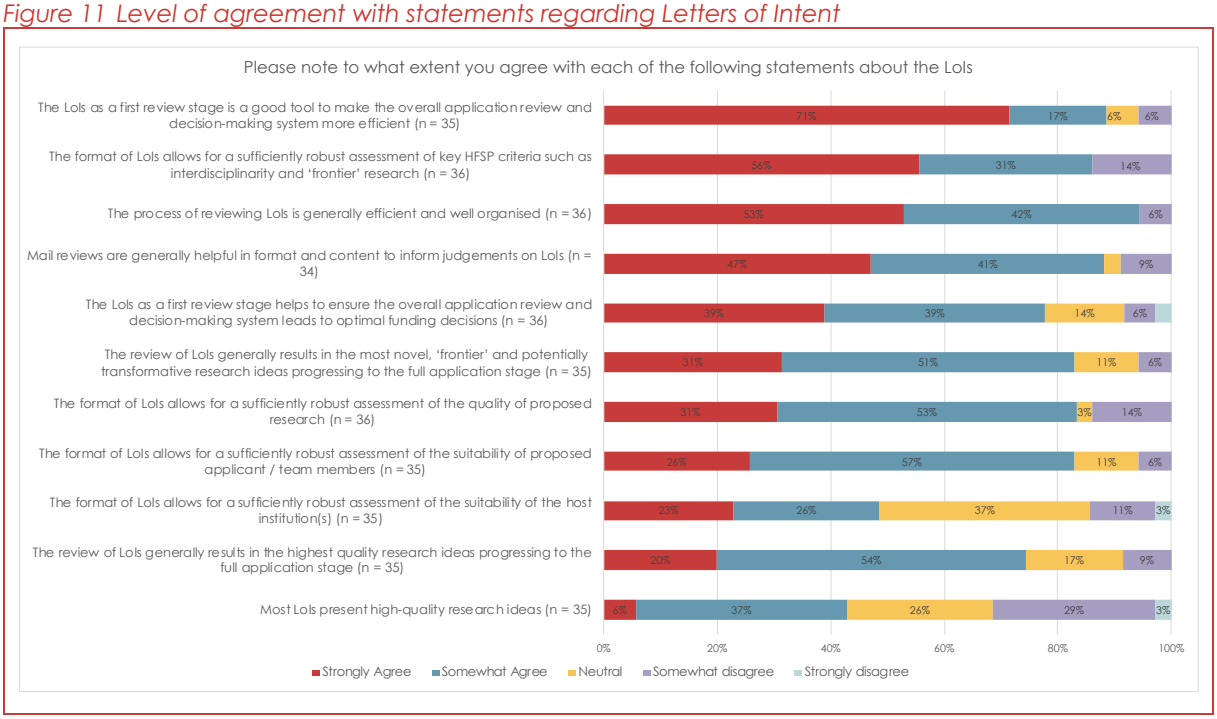
This may further stretch the capacity of the HFSP secretariat, which plays a significant part in screening and sifting the LoIs. However, it also means that the bulk of decision-making (i.e. by far the largest proportion of rejected applications) occurs at the LoI rather than the full application stage. In short, it is at the LoI stage where an especially small number of potentially valuable ideas need to be identified from an especially large pool. In light of the expansion of LoIs to the fellowship schemes, it is critical therefore to look more closely at the LoI stage and whether it contains any hazards not evident in the full application stage.

[4] Some of our comparator schemes have LoI-type screening stages others do not, and funders do not always specify whether their stated success rates include or exclude this application stages. Some caution is therefore required for direct comparisons. However, in general the numbers are such that the HFSP success rate figures are lower than the comparator average, especially given that many comparators do not have LoI-type stages.

We asked the subset of committee members who reported also having reviewed LoIs to assess this specific part of the HFSP grant awarding process on a range of criteria. In operational terms, especially in terms of ensuring greater efficiency, the LoI stage is rated very highly. However, we note overall that respondents are less uniformly positive on LoIs than they are on overall process aspects reported in the first main section of this report.[5] In most cases, respondents agree only 'somewhat' rather than 'strongly' with the statements given in the survey item.

A substantial share of committee members is at best moderately confident that LoIs ensure optimal funding decisions, or that LoIs generally result in the highest quality research ideas progressing to full application stage. However, we also note that just over half of the respondents 'strongly agree' that the LoIs allow for sufficiently robust assessment specifically of interdisciplinarity and 'frontier' dimensions of proposed research. A small number of committee members added comments to this survey item. Four of these mentioned that they felt the LoI review process could be too brief, and the applications may lack scientific content, making it difficult to assess the best projects.

Figure 11 Level of agreement with statements regarding Letters of Intent



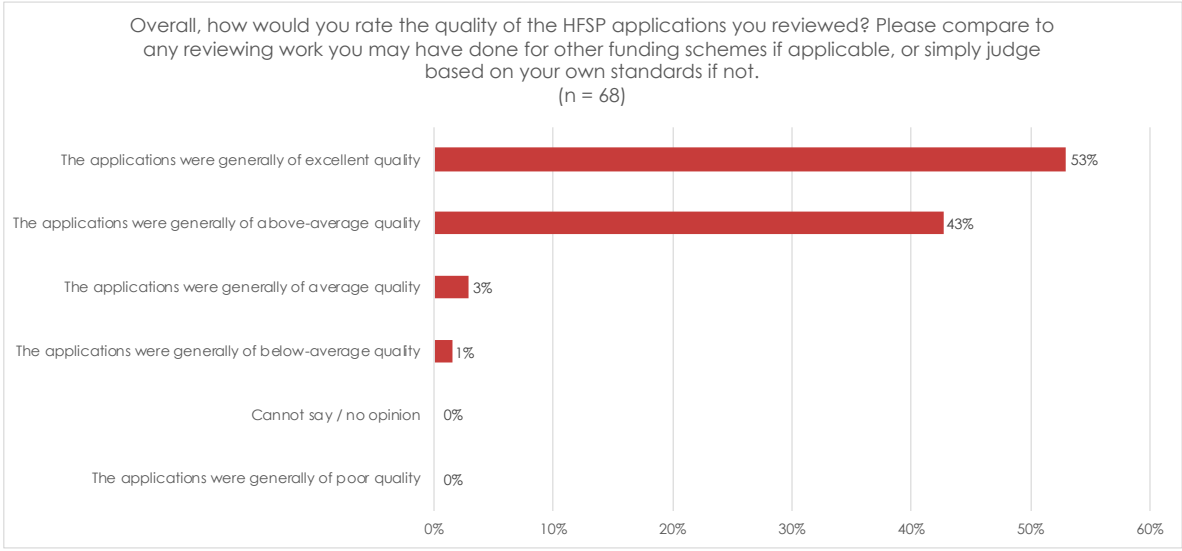
Survey of HFSP Committee Members, Apr 2022. Graph excludes 'Don't know / Not applicable' responses.

Crucially, committee members are especially critical of the overall quality of the LoIs. A third disagree with the statement that most LoIs present high-quality research ideas, while only 6% 'strongly agree'. This stands in considerable contrast to committee members' assessment of full HFSP applications, which are deemed of high quality.[6]

[5] We note that the wording of the scale here is slightly different, as it asks about 'agreement' rather than 'satisfaction' (see Figure 1 and Figure 2). However, it is also a 5-point scale and so a degree of equivalence is given.

[6] We asked a similar question to mail reviewers, who returned a very similar verdict on full HFSP applications, see Appendix section A.2.2.

Figure 12 Committee members' judgement on the overall quality of HFSP full applications



Survey of HFSP Committee Members, Apr 2022. Opinions are based on HFSP applications and do not include opinions of HFSP Letters of Intent. They may relate to full applications either for grants or fellowships or both, depending on each respondent's committee membership

We had several additional comments submitted in various parts of our data collection that echo these points, particularly around the overall quality of the pool of LoIs, as well as the difficulty of reliably selecting a very small cohort of the highest quality, most interdisciplinary and 'frontier' ideas from such a large pool, using only the LoIs in their current format. We have also had sight of a small sample of LoIs and note that while they tend to contain substantial amounts of information on the applicant(s) and their track record, the actual project description is minimal, especially for the recent fellowship LoIs

In summary, we make the following observations about demand, success rate and LoIs:

- The HFSP awards are very competitive, with success rates substantially lower than the average of comparator schemes. This means there is a large review burden for a relatively small number of awards. Introducing an LoI stage for grants substantially reduced the burden of full application review and will likely accomplish the same for fellowships
- The introduction of LoIs has however meant a higher influx of applicants due to the lower barriers to entry. A similar effect may also be expected for the introduction of LoIs to the fellowship. Administering this higher influx may put additional pressure on the HFSP secretariat
- Lower barriers to entry mean, firstly, that many poor-quality research ideas enter the HFSP system. Secondly, the large pool of LoIs means that a lot of sifting is required so that a much smaller and manageable pool of full applications can be solicited
- While the pool of full applications is generally regarded as being of very high quality, there are quite widespread concerns whether the LoI stage in its current format is ideally set up to genuinely identify and foster all of the best, most 'HFSP-worthy' ideas

We therefore judge that the introduction and organisation-wide mainstreaming of LoIs was an important and necessary step, but that the LoI stage may need reform to the effect of slightly heightening barriers to entry (to discourage unsuitable applications) and enabling more robust assessment of ideas.

5 Challenge II: Diversity of region, gender and field

Our research highlights some concerns around diversity in the HFSP, specifically in the areas of region or country, gender, and field of science (or 'types' of interdisciplinarity). Some of these concerns pertain to the application intake, in other words, who exactly is or is not applying to HFSP in the first place. Others pertain to the outcomes of the HFSP application review processes, in other words, which types of applicants tend to be more successful than others.

We note that issues around diversity and inclusion were mentioned frequently across our data collection, often un-prompted, including in our survey of committee members, our interviews and our consultation of supporting parties. However, there are varying views around whether these issues constitute a problem and whether any action should be taken to address them. There are some concerns that too much focus on diversity might risk undermining the HFSP's focus on 'frontier' research, novel interdisciplinary approaches and 'excellence' more generally. However, the majority of views we heard are in favour of addressing diversity issues, for a number of different reasons:

- First, there is an inherent issue around fairness, especially if some unequal outcomes of the funding processes are attributable to unconscious bias
- Second, many participants in our study see strategic merit in expanding the HFSP to constituencies (especially regions/countries) where either uptake or success rates have so far been low
- Third, it is possible that there are in fact many important 'frontier' research ideas precisely in the currently underrepresented constituencies that are at present not being captured by the HFSP

5.1 Diversity by region and country

In general terms, we note that on all measures we are able to capture, the HFSP is strongly focused on North America, Europe, and Japan, while there is almost no representation from Africa or the Middle East.

These overall differences are reflective of the overall size and global strength of the research systems in these different regions. However, we find that in detail there are more complex patterns worth considering. If we look specifically at application and success rates from different countries, an especially complex picture emerges. There is a wide range of different success rates among different countries, and even substantial differences between success rates at LoI and full application stage. Specifically, we note:

- In terms of application volume, EU countries, the USA and Japan are very dominant. Populous emerging economies with rapidly growing science systems (e.g. China, India, Brazil) are comparatively far less well represented in the application pool
- There is no relationship between a country's volume of applications/LoIs and its success rates
- Among the top-20 countries by application rate, grant success rates range from 20% to 50% for full applications (with Mexico as an outlier at 0%), and from 3% to 21% at LoI stage, while fellowship success rates (prior to introduction of LoIs) vary among countries from 4% to 28%
- Generally, countries with the most advanced economies and the longest-established science systems tend to have higher success rates than emerging economies. However, this is far from absolute and in no way a 'perfect' correlation

- Interestingly, there is also at best a weak relationship between countries' respective LoI-to application and application-to-award success rates. Italy, for example, has amongst the lowest LoI-to-application success rates, but its application-to-award success rates are around the middle. New Zealand, by contrast, has the second-highest LoI-to-application success rate, but a very low application-to-award success rate

Table 1 Application and success rates by country, HFSP grants 2002-2021

Country	LoIs	Grant Applications	Awarded Grants	LoI-to-Application rate (rank /20)	Application to Award rate (rank /20)
EU27 excl. DE, IT, FR*	3,110	323	123	10.4% (15)	38.1% (10)
USA	3,044	336	130	11.0% (11)	38.7% (8)
Germany	1,597	219	87	13.7% (6)	39.7% (7)
Italy	1,501	106	41	7.1% (18)	38.7% (9)
UK	1,152	150	56	13.0% (7)	37.3% (11)
France	987	121	56	12.3% (8)	46.3% (2)
Japan	769	91	39	11.8% (9)	42.9% (3)
Canada	761	85	31	11.2% (10)	36.5% (12)
Australia	502	52	17	10.4% (14)	32.7% (13)
India	361	22	9	6.1% (19)	40.9% (6)
Switzerland	229	47	20	20.5% (1)	42.6% (4)
China	188	17	7	9.0% (16)	41.2% (5)
South Korea	170	18	5	10.6% (13)	27.8% (17)
Israel	147	20	6	13.7% (5)	30.0% (14)
Russia	119	10	3	8.4% (17)	30.0% (15)
New Zealand	106	20	5	18.9% (2)	25.0% (18)
Argentina	54	10	5	18.5% (3)	50.0% (1)
Singapore	48	7	2	14.6% (4)	28.6% (16)
Brazil	46	5	1	10.9% (12)	20.0% (19)
Mexico	34	1	0	2.9% (20)	0.0% (20)

Source: Data provided by HFSPO, top-20 countries by LoI numbers only. *EU27 excluding the countries in the European Union who fund HFSP in their own right: France, Germany, and Italy

Table 2 Application and success rates by country, HFSP fellowships 1993-2021

Country	Fellowship applications	Awarded Fellowships	Success rate (rank /20)
EU27 excl. DE, IT, FR*	4,488	550	12.3% (12)
France	2,801	350	12.5% (11)
Japan	2,262	363	16% (7)
Germany	1,787	399	22.3% (3)
India	1,465	73	5% (19)
Israel	1,070	253	23.6% (2)
UK	1,062	138	13% (9)
Canada	1,031	212	20.6% (4)
Italy	1,007	127	12.6% (10)

Country	Fellowship applications	Awarded Fellowships	Success rate (rank /20)
USA	887	143	16.1% (6)
China	607	74	12.2% (13)
Australia	522	58	11.1% (14)
Argentina	355	38	10.7% (15)
Switzerland	281	78	27.8% (1)
South Korea	263	44	16.7% (5)
Russia	224	17	7.6% (17)
Brazil	207	15	7.2% (18)
Mexico	172	17	9.9% (16)
Taiwan	98	15	15.3% (8)
Iran	93	4	4.3% (20)

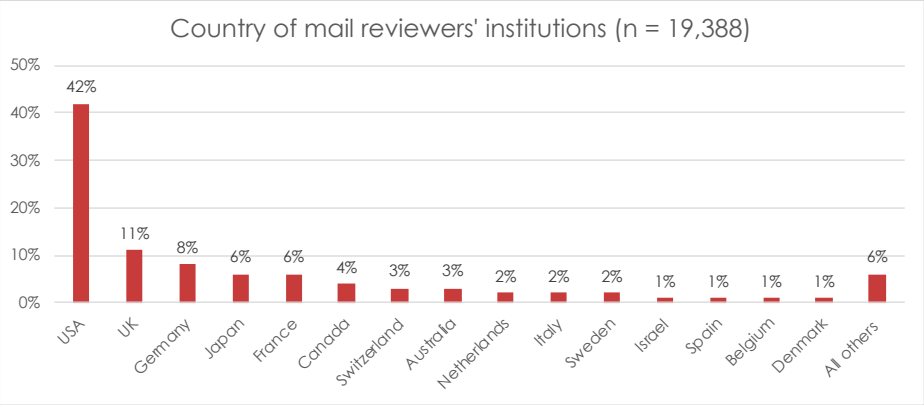
Source: Data provided by HFSPO, top-20 countries by application numbers only. *EU27 excluding the countries in the European Union who fund HFSP in their own right: France, Germany and Italy

Our headline conclusion from these figures is that researchers in different countries appear to behave quite differently towards the HFSP. In countries where application rates are very high, it is possible that there is simply less comparable funding available at the national level. However, there may also be more 'signposting' towards the HFSP, for example via the presence of many HFSP alumni able to spread the aforementioned HFSP-culture.

Where LoI-to-application success rates are low, it is possible that there is a degree of miscommunication around what an HFSP application should involve. The mixed quality of the overall pool of LoIs (see previous section of this report) may therefore be in part attributable to countries with a high volume of unsuccessful LoIs, potentially rooted in a lack of clear communication of what the HFSP is looking for.

Aside from these contextual factors, it is also worth looking at national/regional representation within the HFSP itself. We note that there is an especially strong skew in the pool of mail reviewers: over half of all mail reviewers used by the HFSP since its inception have been based either in the USA (42%) or the UK (11%).

Figure 13 institution country of HFSP mail reviewers, 1996-2022

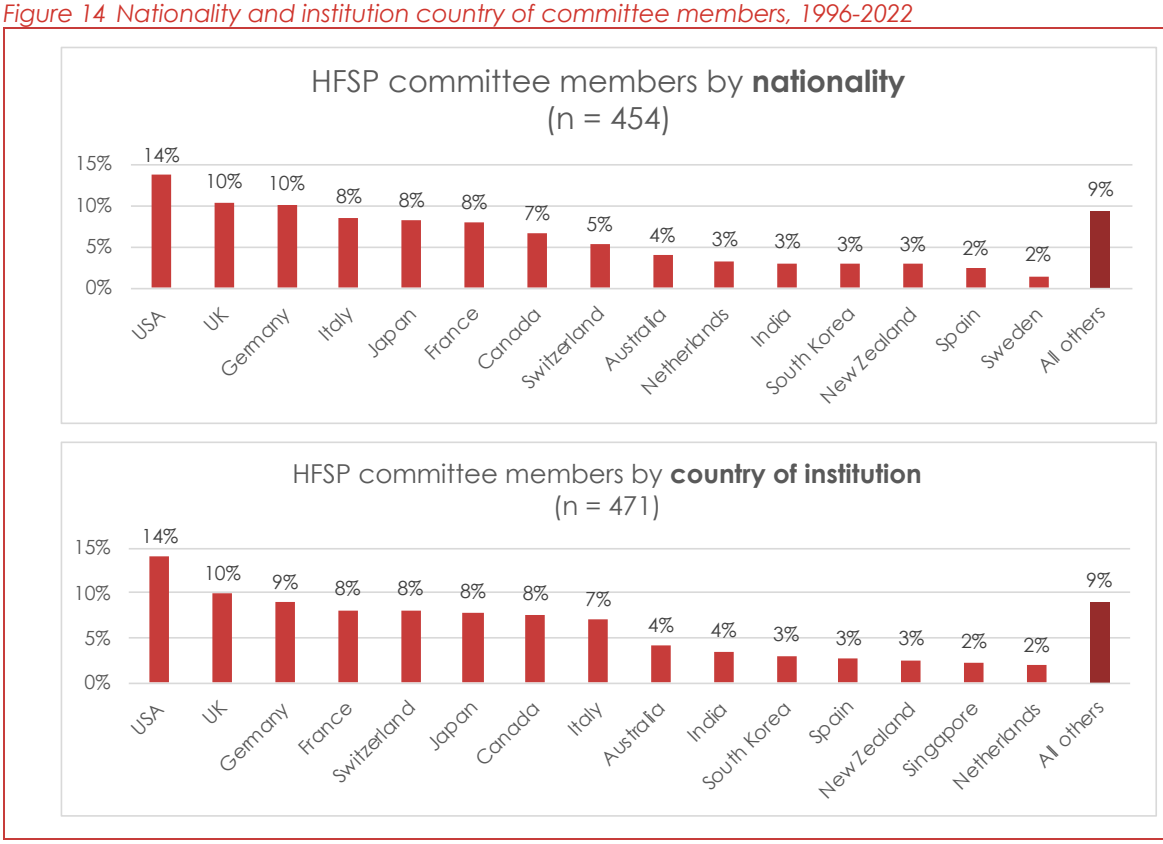


There were 36,560 mail reviews from 1996 to 2021 but some mail reviewers took part in more than one year, so there are 19,405 unique mail reviewers over the period. Each individual is only included once in this graph. Out of 19,405 individuals who have acted as a mail reviewer from 1996 – 2021, there Is information about the country of their institution for 19,388.

Whilst the USA and UK are generally acknowledged as having world-leading science systems, these figures are disproportionate. We have no evidence for any unconscious bias among mail reviewers. However, if there are any national or regional differences in terms of what topics and themes are regarded as important within the life sciences, these might then also be reflected in the national skew of the mail reviewer pool.[7]

For committee members, there is significantly less skew to the USA and UK. In fact, the proportions of committee member nationalities and institutional affiliations broadly reflect the proportions of HFSP applications and awards by country. This may in part reflect the rule that each HFSP-supporting country must have at least one committee member, and that the strongest and largest science systems also producing the largest numbers of suitable members. However, there may also be a degree of circularity. Anecdotally, we have heard that current or former HFSP committee members can act as 'champions' of the HFSP within their country, institution and/or sub-field, spreading awareness of the HFSP, explaining its aims and recommending potentially suitable individuals to apply. The strong similarity in national composition of HFSP committee members, applicants and award holders may therefore be at least in part attributable to the fact that the HFSP culture has taken hold in some places more than in others.

Figure 14 Nationality and institution country of committee members, 1996-2022

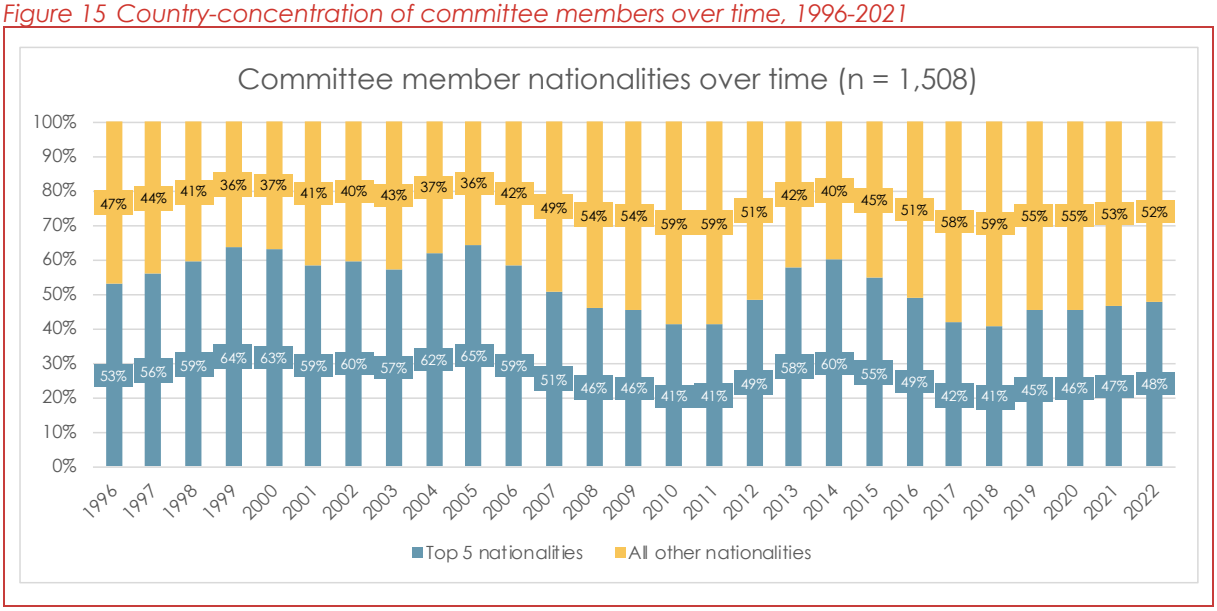


Source: Data provided by HFSPO

[7] We note that this is generally more common in applied science, e.g. where certain health conditions or hazards are far more common in some regions of the world than in others, potentially leading to different thematic emphases and understandings of 'importance' or 'relevance'. However, there may also be traces of this in non-applied science.

We note that the figures shown above are historical. Over time, there has been some movement in terms of committee members' nationality, perhaps in part because of new member countries joining the HFSP around 2004. However, long-term trends towards more balanced committee membership do not appear to have been maintained in recent years: in the 1990s and early 2000s, around 60% of committee members were concentrated in just 5 countries. This proportion has reduced to around 45% in recent years but appears to have stabilised there.

Figure 15 Country-concentration of committee members over time, 1996-2021



Source: Data provided by HFSPO. *Graph shows the share of committee members from the top-5 countries each year between 1996-2021. The top 5 nationalities were USA, Germany, UK, Italy and Japan.*

5.2 Diversity by Gender

Historically, the HFSP has had significant shortcomings around gender representation. This includes gender representation in terms of application rates, success rates and on HFSP committees.

Unequal gender ratios at the point of application are to be expected: inequality at this point may simply reflect the uneven gender balance in the scientific community more broadly. The gender ratio between men and women in science varies a lot by country, by field and by career stage. As a general reference figure, gender ratios of between 40/60 and 25/75 in favour of men are common in many countries for the population of natural scientists of postdoctoral level and above, with ratios generally moving further in favour of men at more senior career stages.[8]

It is a matter of strategic decision for the HFSPO whether it wishes to actively intervene to change these deeper gender inequalities in the global science system as a whole (for example through advocacy or introduction of funding schemes sensitive to inequalities around

[8] For some example figures centering mostly on EU-countries but with several international comparators, see the latest She Figures: https://op.europa.eu/o/opportal-service/download-handler?identifier=67d5a207-4da1-11ec-91ac-01aa75ed71a1&format=pdf&language=en&productionSystem=cellar&part=

gender[9]). However, it is not in itself a shortcoming of the HFSP that the gender inequality among applicants more-or-less reflects the gender inequality in the scientific community more broadly.

More concerning is that there have been inequalities historically in terms of outcome: regardless of application numbers, applications by women have been funded less often than those by men.

Table 3 All-time HFSP application and success rates by gender

PIs by Gender & Grant type	LoIs	Applications	Awards	LoI-to-Application conversion	Application-to-Award Success Rate
HFSP Grants, 1990-2001, lead investigators					
All Women's Grants 1990-2001	*NA*	*344 (15%)*	*48 (11%)*	*NA*	*14.0%*
All Men's Grants 1990-2001	*NA*	*1921 (85%)*	*370 (89%)*	*NA*	*19.3%*
HFSP Grants, 2002-2021, lead investigators					
All Women's Grants 2002-2021	*3619 (24%)*	*367 (22%)*	*130 (20%)*	*10.1%*	*35.4%*
All Men's Grants 2002-2021	*11588 (76%)*	*1318 (78%)*	*518 (80%)*	*11.4%*	*39.3%*
HFSP Grants, 2002-2021, Co- investigators					
Women Co-Is 2002-2021	6333 (20%)	702 (19%)	270 (19%)	11.1%	38.4%
Men Co-Is 2002-2021	25172 (80%)	2995 (81%)	1167 (81%)	12.0%	39.0%
HFSP fellowships, excluding years 1993-1997 and 1999-2000*					
All Women PIs Fellowships	*NA*	6284 (39%)	733 (32%)	*NA*	11.7%
All Men PIs Fellowships	*NA*	9924 (61%)	1537 (68%)	*NA*	15.5%

Source: Data provided by HFSPO

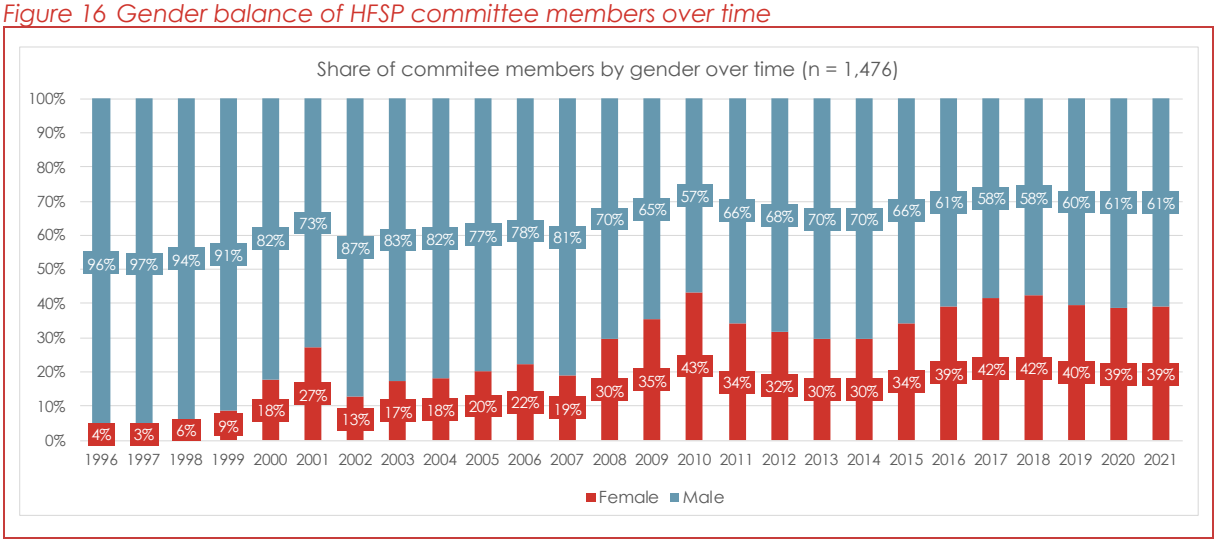
The HFSP's historical gender inequality is especially clear when looking at committee composition: in 1997, just 3% of HFSP committee members were female. This rose to around 20% by the mid-2000s.

However, over the past decade, substantial efforts have been made to address these gender inequalities. This has included efforts to balance committee membership, as well as briefings and documentation on unconscious bias. There have also been some rule changes around award management, e.g. to enable parental leave to take place more easily.

Since the late 2000s, there is a clear trend towards a more representative gender balance on HFSP committees, which has now stabilised to a 60/40 ratio. This is still in favour of men, and it is once again a strategic decision for the HFSPO whether a full 50/50 ratio should be aimed for. However, the figures as they stand are now broadly reflective of the scientific population more broadly.

[9] See e.g. the UK Royal Society's Dorothy Hodgkin Fellowship.

Figure 16 Gender balance of HFSP committee members over time



Source: Data provided by HFSPO. NB: committee members typically serve for more than one year, so these figures contain significant double-counting. The aim of this graph is not to count individual members, but to show how the gender ratio of HFSP committee members evolved year-on-year

Likewise, there has been substantial improvement in terms of success rates for female applicants. Looking only at the last three full calendar years, outcomes for HFSP fellowship applicants are no longer unequal in terms of gender, and those for grants are only marginally unequal at the full application stage.

The HFSPO must be lauded for its efforts and successes in tackling and largely solving these historic inequalities. However, even for the most recent period, there is still a clear inequality of outcomes for female principal investigators at the LoI stage for HFSP grants. We did not find unequal gender-based outcomes for co-investigators.

Table 4 Success rates by gender – last three years only

Gender	LoIs	Applications	Awards	Application to Award success rate	LoI to Award success rate
Total (grants and fellowships) 2019-2021					
Women PIs	n/a	919 (41%)	110 (38%)	12.0%	n/a
Men PIs	n/a	1341 (59%)	182 (62%)	13.6%	n/a
Grants only 2019-2021					
Women PIs	632 (29%)	68 (26%)	22 (25%)	32.3%	3.5%
Men PIs	1582 (71%)	195 (74%)	67 (75%)	34.4%	4.2%
Fellowships only 2019-2021					
Women PIs	n/a	851 (43%)	88 (43%)	10.3%	n/a
Men PIs	n/a	1146 (57%)	115 (57%)	10.0%	n/a

Source: applications and awards data provided by HFSP

It is not entirely clear from our research why outcome-inequalities persist specifically at the LoI-stage. However, the likeliest explanation is that the review process for LoIs is much shorter than that for full applications and a much smaller selection needs to be made from a much larger

pool. Unconscious bias may therefore be more likely to affect this stage than the full application stage. Secondly, we noted previously that the LoIs tend to devote a lot of space to information on the applicant's background and only minimal information on the proposed project. This may also contribute to possibilities of unconscious bias.

Whilst we have not found direct evidence of unconscious bias in the HFSP's programmes, there is a substantial literature noting that, first, women are generally under-represented among peer reviewers, panellists and editors worldwide (the literature variously covers review for grant funding or for publication in journals), and that there is often evidence of same-gender preference (homophily).[10] There is little available evidence on how more diverse peer reviewers and panel members affects outcomes. The limited evidence that exists points to a complex picture, where some effects can be observed, but where an improved gender balance among reviewers does not necessarily equal an improved gender balance among funded (or published) individuals.[11]

Whilst gender inequalities in the HFSP have reduced significantly over the past decade, we caution that challenges might lie ahead: LoIs have most recently also been introduced to the fellowship schemes, so there is a possibility that further inequalities of outcome may creep back into the process. We urge the HFSPO to track the fellowship success rates carefully after the introductions of LoIs.

5.3 Diversity by field

The final diversity issue we identify around the HFSP is considerably harder to quantify than the two other areas covered in this section. However, it relates to a few other points made elsewhere in this report and may provide further strategic options for expansion of the HFSP into 'uncharted' territory.

In the first section of this report, we noted that the HFSP review processes generally result in the highest quality and the most 'frontier' applications being funded. However, respondents were less uniformly confident that the HFSP consistently identifies and funds the most novel interdisciplinary approaches. Interdisciplinarity cannot readily be quantified, and so we rely here on anecdotal evidence and the assessments provided through our interviews and other consultations.

Several participants to our study note that in the early days of the HFSP, much of the funded awards centred on molecular biology. More recently, a major trend has been towards crossovers between biology and data science/mathematics, with physics, material science and robotics also featuring prominently. Some participants also noted that there have recently been some HFSP applications and awards in the area of ecology and behavioural sciences,

[10] Fox CW, Burns CS & Meyer JA (2016) 'Editor and reviewer gender influence the peer review process but not peer review outcomes at an ecology journal.' Functional Ecology, 30/1, pp. 140-153; Helmer M, Schottdorf M, Neef A & Battaglia D (2017) 'Research: Gender bias in scholarly peer review' eLife 6:e21718; Chawla, DS (2018) 'Huge peer-review study reveals lack of women and non-Westerners.' Nature News 18 September 2018. Available: https://www.nature.com/articles/d41586-018-06678-6; Murray D, Siler K, Larivière V, Mun Chan W, Collings AM, Raymond J, Sugimoto CR (2019) 'Gender and international diversity improves equity in peer review.' bioRxiv 400515; doi: https://doi.org/10.1101/400515

[11] Van den Besselaar P & Mom C (2021) 'What leads to gender bias in review panels?' Conference: 18th International Conference on Scientometrics & Informetrics ISSI 2021, Leuven, Belgium, July 12-15, 2021: https://www.researchgate.net/publication/356854548_What_leads_to_gender_bias_in_review_panels

but only on a small scale. Meanwhile, there appear to be almost no crossovers, either at application or award level, between life sciences and social sciences or humanities.[12]

Some participants questioned how path-breaking the interdisciplinary approaches funded by the HFSP actually are. This included concerns around whether, for example, biology and data science crossovers are in fact still 'interdisciplinary', or whether this combination simply constitutes the way in which a lot of mainstream life science is conducted in the present day.

Some also commented that the HFSP may be limited here by its own constituency and by the limited reach of the aforementioned HFSP culture. The HFSP regularly draws on committee and council members' foresight, as well as on its portfolio of applications, in order to identify possible new emerging areas of crossover between life sciences and other fields. In this way, new committee members can be recruited accordingly. However, the HFSP committees are themselves rooted in a finite set of fields and, in short, can only see what is within their range of perception. Meanwhile, the HFSP itself is well-known and well-regarded in some fields, but completely unknown in others.

While outcomes may be uncertain, there is therefore a case for the HFSP to reach out into fields where it has so far not ventured, to more actively seek out possibilities for completely new, unexpected and uncharted cross-disciplinary horizons.

[12] The UK ESRC's Transformative Research scheme funded several awards between 2012 and 2018 that had crossovers between social and life sciences, especially between neuroscience and sociology/social psychology: https://www.technopolis-group.com/wp-content/uploads/2020/02/Evaluation-of-the-ESRC-Transformative-Research-Scheme.pdf

6 Conclusions and options for reform

Our review finds the HFSP in good health. The impact assessments conducted in recent years highlight the outstanding achievements of HFSP fellows and grant holders. At the level of activities and operations, we can add to these findings that the HFSP is doing the right things and doing them well.

Our consultation and review of supporting parties indicates that the HFSP has added value to individual countries' funding landscape, but that the exact type of added value varies by country: some especially value the emphasis on basic (as opposed to applied) science, others the emphasis on frontier or interdisciplinary research, while the provision of fellowships or international exchange is also noted by some. At an aggregate, global level, no single characteristic of the HFSP is unique, but we have not been able to identify other schemes that combine emphases on frontier research, interdisciplinary research, and international exchange to the extent that the HFSP does.

We also find no major difficulties in the HFSP's processes that would be in severe need of repair: participants in our study consistently rate the organisation and effectiveness of most HFSP process aspects very highly. The secretariat staff are praised especially strongly.

Most importantly, the HFSP application assessment processes largely succeed in identifying the most innovative, 'frontier' research ideas and recommend them for funding. This is known from wider literature to be a difficult task. We conclude that the HFSP succeeds in this respect not primarily through the design of its process structure (as other funders have done), but largely through creating and maintaining a cultural understanding of what the HFSP is trying to achieve.

This HFSP-culture permeates through the secretariat, council, committees, and alumni (and to a lesser extent even to the relatively distant mail reviewers). It ensures that the HFSP's decision-making is genuinely different from that of mainstream research funding processes, even though the HFSP's processes themselves are very similar to those of many national funders.

Relying on predominantly on culture rather than process structure to foster a special 'type' of research also allows for a degree of flexibility with the various HFSP ambitions (i.e. to fund 'frontier' research, novel interdisciplinary perspectives, novel collaborations and international exchange), which helps to avoid these different ambitions coming excessively into conflict with each other, as they might do, were they overly prescribed and formalised. However, reliance on culture also brings some limitations: cultures are fragile and hard to scale. Maintaining the HFSP culture is therefore an on-going task, and rapid expansion or organisational change might risk diluting it.

We identify two core areas of challenge around the HFSP. Firstly, there is an issue of high demand: the HFSP's application success rates are very low, especially when we factor in the LoI stage. This puts substantial pressure on the secretariat, and also means that a very small number of the very best research ideas need to be selected from a large pool of possibilities. There also appears to be a substantial influx of unsuitable, poor-quality LoIs, which nevertheless need to be processed. While the introduction of LoIs (and their recent expansion from grants to fellowships) has been a necessary step to limit review burden and standardise processes across the organisation, there are some concerns whether LoIs allow for proper assessment and recognition of all the most promising research ideas or whether, especially in such highly competitive conditions, some potentially promising ideas cannot be recognised and are consequently lost.

Secondly, we identify some issues around diversity. At present, the HFSP is heavily centred on Europe and North America, in terms of applicants, awards and committee and mail reviewer composition. Historically there has also been severe gender inequality (including in terms of funding process outcomes). These have been lessened considerably, though a degree of inequality of outcome remains specifically for female principal investigators at the LoI stage (though we find no inequitable outcomes for female co-investigators). There are also some concerns around the range of interdisciplinary approaches the HFSP is able to attract. While the HFSP doubtlessly funds innovative interdisciplinary work, it is unclear whether the programme is fully able to connect with fields not represented among its staff and committee members, or where the HFSP-culture has little or no reach.

6.1 Recommendations and avenues for change

There is a fundamental tension between the two core challenges we identify: on one hand, there is substantial scope for growth of the HFSP, most notably into new geographical regions and, potentially, into new areas of crossover between fields. On the other hand, the HFSP already has stretched supply. This is not only a matter of available funding, though participants consistently noted that there are always additional applications that 'could' be funded in terms of the satisfying the criteria, if there were more budget available. But there is also an issue around finite human resources. Because culture is so important in the HFSP's functioning, substantial rapid expansion of the programme is likely to present difficulties.

Our findings point to a range of possible reforms of the HFSP. Following discussion of these with the HFSP Council of Scientists and secretariat in July 2022, we can distil these into a small set of concrete recommendations and a further set of more general possible avenues for change. In various ways, most of these relate to the fundamental tension between scope for growth on one hand and the need to preserve the HFSP culture on the other.

Our recommendations are as follows:

- Our headline recommendation is that there is a clear case for the HFSP to grow, both in terms of its overall budget and its human resources. However, in light of the importance of maintaining the HFSP culture, such growth needs to be gradual rather than sudden
- While the use of LoIs is necessary, the HFSP should consider changing the format of the LoIs. Key aims of this should be to slightly raise barriers to entry, to ensure that applicants' research ideas can be assessed as robustly as possible, and to minimise possibilities of unconscious bias. In detail, this might mean
  - Expanding the amount of required description of the proposed project, while reducing the amount of information on the applicant(s) themselves, their track and background
  - Limiting the number of personal identifiers visible to reviewers/committee members
  - Adding a short section to the LoIs asking applicants to explain why their research idea is suitable and appropriate for the HFSP. This need not be detailed (e.g. half a page maximum) but may better ensure applicants familiarise themselves with the aims of the HFSP and limit submission of out-of-scope LoIs
- The HFSP could further diversify its committees in terms of nationality and/or country of institution so that individuals from non-member countries are increasingly present
- The HFSP should ensure that mail reviewers are less concentrated in just a small number of countries

Additional avenues for change are as follows:

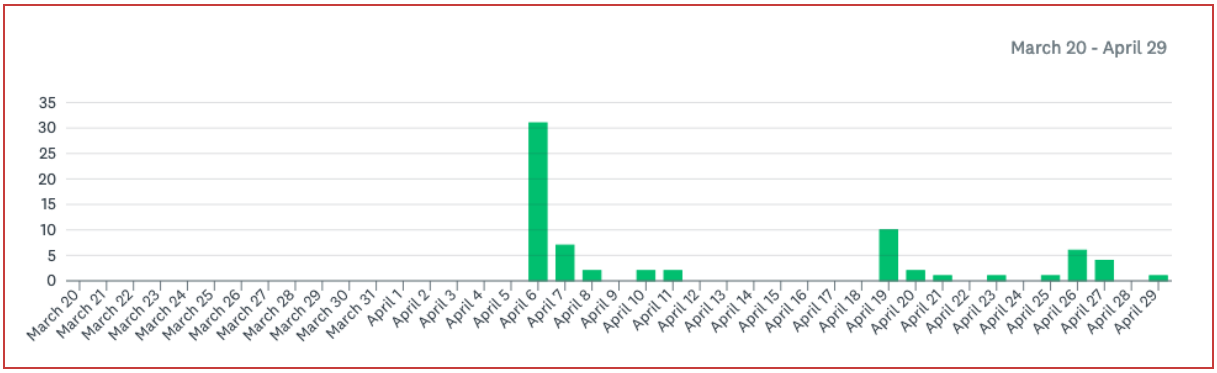
- The HFSP could make further efforts to not only make its gender balance representative of the wider science community, but to actively seek to address the gender inequalities of the global science landscape. Increasing the committee gender ratio to a consistent minimum of 50/50 might be one step. Advocacy for women in science might be another option
- To further guard against unconscious bias, the HFSP could introduce double-blind reviewing of LoIs (i.e. reviewers/committee members have no information on the applicant and only of the proposed research idea). A 'light' version of this might be that research idea and applicant track are reviewed in separate stages or by different people, where the former is double-blind and the latter is not
- There is ample scope and justification for the HFSP to engage in more science diplomacy and outreach. Such efforts could help to address the inequalities we have highlighted, to help spread the HFSP culture, and thereby to increase the HFSP's ability to grow:
  - Events to convene HFSP alumni (as already conducted) could enable identification of new committee members and further help maintain the HFSP culture
  - Large conferences and symposia featuring especially notable alumni (potentially in combination with other non-affiliated world leading scientists) may help to raise the profile of the HFSP, attracting new applicants and communicating/clarifying what the HFSP is about
  - We suggest that an especially effective strategy would be to undertake targeted events to expand the HFSP culture into areas where it is currently less well known:
    - Specific regional summits or conferences are a key possibility here, in countries or regions currently underrepresented. This might include countries with organisations that might consider becoming an HFSP supporting party, or countries far removed from such a possibility. Where a small number of researchers from those regions have held HFSP awards, their work could be showcased here
    - HFSP could also partner with funders outside of the life sciences to organise specific cross-disciplinary events, in order to scope out new horizons for novel disciplinary crossovers. In cases where a lot of crossover is very likely and already occurring, these events could be of a larger and high profile conference format; in settings where there is less certainty of fruitful results (e.g. life sciences and humanities), smaller and more 'experimental' events could be considered, to spread the HFSP culture and explore possibilities in the least well-charted territories
    - Thematic events might also be a possibility, for instance around topics of particular interest to certain regions or demographics of the world – for instance around particular UN Sustainable Development Goals or topics that may have a gendered dimension
- Relating to these latter possibilities, the HFSP could also consider targeted regional or thematic calls for applications. For this purpose, it could also draw on its existing alumni and committee members to form temporary region or topic/field-specific panels to lead the reviewing work for such calls

Appendix A Survey details

A.1. Populations, timings and response rates

Table 5 Survey of HFSP Committee members – response rates

Survey of HFSP Committee members					
Total Population:	**137 (124)**	**Survey responses:**	**70**	**Response rate:**	**51.1%**
Population notes: Population includes all individuals who were members of any HFSP committees at any point over the past five full calendar years (2017-2021), including for grants, fellowships as well as the now-defunct Career Development Awards 12 invitations bounced and 1 respondent had opted out of receiving surveys, so 124 could be invited to take the survey.		Response notes: Responses were collected between 06/04/2022 and 29/04/2022, Involving one initial invite and two reminders (see graph below). The population of respondents largely reflects the total population on all characteristics we are able to control for (see table below). This means that our survey data are likely strongly representative of the total population.		Response rate notes: With a population (N) of 137 it is not possible to analyse for statistical significance. However, this high response rate and representative response pool ensures that our survey data can produce the strongest possible indicative and robust findings.	



Source: Surveymonkey.

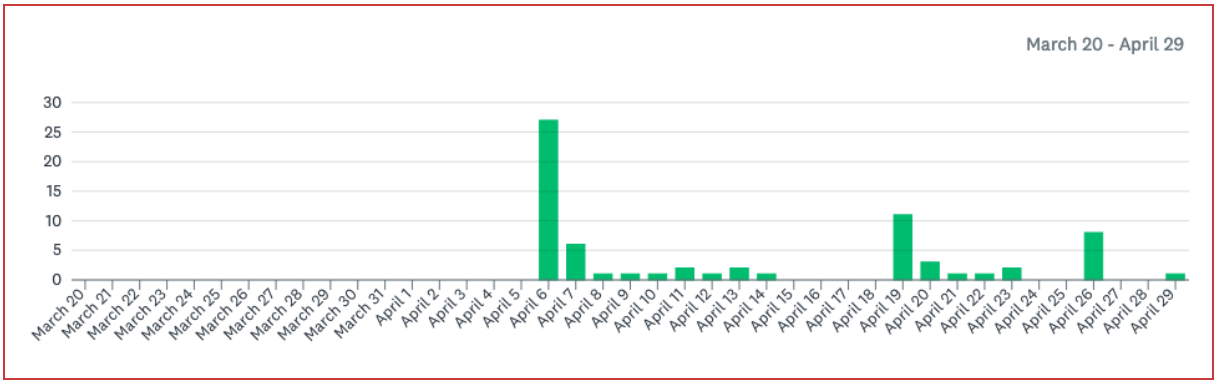
	Total population (N=137)		**Responses (n=70)**	
	Number	**%**	**Number**	**%**
Committee type				
CDA	14	10%	8	11%
LT	61	44%	28	40%
RG	63	46%	34	49%
Gender				
Male	82	59%	40	57%
Female	56	41%	30	43%

	Total population (N=137)		Responses (n=70)	
	Number	%	Number	%
Country of institution				
USA	15	11%	7	10%
France	12	9%	6	9%
Germany	11	8%	2	3%
Switzerland	11	8%	4	6%
UK	10	7%	7	10%
All other countries (<10)	94	68%	51	73%
Age group (by decade of birth)				
1940s	2	1%	2	3%
1950s	27	20%	16	23%
1960s	65	47%	28	40%
1970s	40	29%	21	30%
1980s	4	3%	3	4%
Academic title				
Prof.	97	70%	46	66%
Dr.	41	30%	24	34%

Table 6 Survey of HFSP mail reviewers – response rates

Survey of HFSP mail reviewers					
Total Population:	**170 (163)**	**Survey responses:**	**69**	**Response rate:**	**40.6%**
Population notes: Population includes all individuals who conducted at least two mail reviews for any HFSP application type since 2017 OR at least three mail reviews since 2010. 4 invitations bounced and 3 respondents had opted out of receiving surveys, so 163 could be invited to take the survey.		Response notes: Responses were collected between 06/04/2022 and 29/04/2022, Involving one initial invite and two reminders (see graph below). Unlike for the survey of committee members (see above), the data we received from HFSP on mail reviewers do not include characteristics beyond names and email addresses, so we cannot assess the extent to which our response pool is representative along line of, for instance, gender, age or country. However, given that this survey was run simultaneous to the survey of committee members, using almost		Response rate notes: With a population (N) of 170 it is not possible to analyse for statistical significance. However, the relatively high response rate and likely representative response pool means that our survey data can produce the strongly indicative and robust findings.	

	identical tools and conventions, we are confident that bias is minimal.	



Source: Surveymonkey.

A.2. Raw survey data

A.2.1. Survey of committee members

How many years of full-time professional research experience (excluding PhD study) did you have when you first became an HFSP committee member?		
Answer Choices	Responses	
0-4 years	1.43%	1
5-9 years	7.14%	5
10-14 years	30.00%	21
15-19 years	18.57%	13
20-24 years	21.43%	15
25-29 years	8.57%	6
30 years or more	12.86%	9
	Answered	**70**
	Skipped	**0**

How many articles in international, peer reviewed academic journals had you published over the course of your career when you first became an HFSP committee member, either as sole-author or co-author? (please approximate as closely as you can, including research articles and review papers but excluding book reviews and editorials)		
Answer Choices	Responses	
Fewer than 10	0.00%	0
10-24	8.57%	6
25-49	25.71%	18
50-99	40.00%	28
100-199	18.57%	13
200 or more	7.14%	5
	Answered	**70**
	Skipped	**0**

Prior to becoming a committee member for the HFSP, how many individual research funding applications had you reviewed over the course of your academic career? (If you are unsure, please estimate as closely as you can)		
Answer Choices	Responses	
Fewer than 10	4.29%	3
10-24	20.00%	14
25-49	22.86%	16
50-99	28.57%	20
100-199	15.71%	11
200 or more	8.57%	6
	Answered	**70**
	Skipped	**0**

Have you ever participated in reviewing 'Letters of intent' (LoIs) for the HFSP?		
Answer Choices	Responses	
Yes	51.43%	36
No, I have only participated in review and discussion of full HFSP applications	45.71%	32
Not sure	2.86%	2
	Answered	**70**
	Skipped	**0**

Please note to what extent you agree with each of the following statements about the LoIs													
	Strongly Agree		Somewhat Agree		Neutral		Somewhat disagree		Strongly disagree		Don't know / Not applicable		Total
The format of LoIs allows for a sufficiently robust assessment of the quality of proposed research	30.56 %	11	52.78 %	19	2.78 %	1	13.89 %	5	0.00 %	0	0.00 %	0	36
The format of LoIs allows for a sufficiently robust assessment of key HFSP criteria such as interdisciplinarity and 'frontier' research	55.56 %	20	30.56 %	11	0.00 %	0	13.89 %	5	0.00 %	0	0.00 %	0	36
The format of LoIs allows for a sufficiently robust assessment of the suitability of proposed applicant / team members	25.00 %	9	55.56 %	20	11.11 %	4	5.56 %	2	0.00 %	0	2.78 %	1	36
The format of LoIs allows for a sufficiently robust assessment of the suitability of the host institution(s)	22.22 %	8	25.00 %	9	36.11 %	13	11.11 %	4	2.78 %	1	2.78 %	1	36
Mail reviews are generally helpful in format and content to inform judgements on LoIs	44.44 %	16	38.89 %	14	2.78 %	1	8.33 %	3	0.00 %	0	5.56 %	2	36
The review of LoIs generally results in the highest quality research ideas progressing to the full application stage	20.00 %	7	54.29 %	19	17.14 %	6	8.57 %	3	0.00 %	0	0.00 %	0	35
The review of LoIs generally results in the most novel, 'frontier' and potentially transformative research ideas progressing to the full application stage	30.56 %	11	50.00 %	18	11.11 %	4	5.56 %	2	0.00 %	0	2.78 %	1	36

The process of reviewing LoIs is generally efficient and well organised	52.78 %	19	41.67 %	15	0.00 %	0	5.56 %	2	0.00 %	0	0.00 %	0	36
Most LoIs present high-quality research ideas	5.71 %	2	37.14 %	13	25.71 %	9	28.57 %	10	2.86 %	1	0.00 %	0	35
The LoIs as a first review stage is a good tool to make the overall application review and decision-making system more efficient	69.44 %	25	16.67 %	6	5.56 %	2	5.56 %	2	0.00 %	0	2.78 %	1	36
The LoIs as a first review stage helps to ensure the overall application review and decision-making system leads to optimal funding decisions	38.89 %	14	38.89 %	14	13.89 %	5	5.56 %	2	2.78 %	1	0.00 %	0	36
Please note any comments you may have about the review of LoIs for the HFSP. Please feel free to include both positive and negative aspects relating to the LoIs in any way.													14
												Answered	**36**
												Skipped	**34**

Comments (n = 14)

- Five committee members commented on the efficiency of LOIs, for both academics and reviewers. However, two committee members think the current format could be made more efficient.
- Four committee members mentioned that they felt the LOI review process could be too brief, and the applications may lack scientific content, making it difficult to assess the best projects.

Reflecting on the structure and content of HFSP application forms, please indicate whether they provide the right amount of information for the committee to make robust judgements on each of the following criteria

	Not enough information		About the right amount of information		Too much information		Don't know / Not applicable		Total
The feasibility of the proposed research	13.24%	9	85.29%	58	0.00%	0	1.47%	1	68
The rigour and robustness of the proposed research plan	11.76%	8	88.24%	60	0.00%	0	0.00%	0	68
The importance of the proposed topic and/or research questions to the wider academic community	8.82%	6	88.24%	60	0.00%	0	2.94%	2	68
The novelty and potentially transformative nature of the proposed research	11.76%	8	85.29%	58	1.47%	1	1.47%	1	68
The track record of the applicant(s)	2.94%	2	94.12%	64	2.94%	2	0.00%	0	68
The reputation, resources and/or facilities of the applicant's/applicants' institution/laboratory	22.39%	15	71.64%	48	1.49%	1	4.48%	3	67
The level of interdisciplinarity of the proposed research or team	16.42%	11	77.61%	52	1.49%	1	4.48%	3	67
The level of internationality or intercontinentality of the proposed team	8.82%	6	85.29%	58	0.00%	0	5.88%	4	68
Diversity criteria (e.g. age, gender, nationality)	20.59%	14	72.06%	49	0.00%	0	7.35%	5	68
								Answered	**68**
								Skipped	**2**

To what extent did the applications you reviewed and/or discussed at HFSP committee meetings reflect your research experience?

Answer Choices	Responses	
They entirely matched my expertise	1.47%	1

They mostly matched my expertise	58.82%	40
They only partially matched my expertise	39.71%	27
They hardly matched my expertise	0.00%	0
Cannot say / no opinion	0.00%	0
	Answered	**68**
	Skipped	**2**

Overall, how would you rate the quality of the HFSP applications you reviewed? Please compare to any reviewing work you may have done for other funding schemes if applicable, or simply judge based on your own standards if not. As above, please consider only full HFSP applications and disregard any reviews of HFSP Letters of Intent (LoIs) you may also have conducted.

Answer Choices	Responses	
The applications were generally of excellent quality	52.94%	36
The applications were generally of above-average quality	42.65%	29
The applications were generally of average quality	2.94%	2
The applications were generally of below-average quality	1.47%	1
The applications were generally of poor quality	0.00%	0
Cannot say / no opinion	0.00%	0
	Answered	**68**
	Skipped	**2**

Please indicate your level of satisfaction with the following aspects connected to the HFSP Committees

	Very dissatisfied		Somewhat dissatisfied		Neutral		Somewhat satisfied		Very satisfied		Don't know / Not applicable		Total
Clarity of HFSPO guidance notes and documentation explaining how the committee would operate	1.47 %	1	1.47 %	1	2.94 %	2	20.59%	14	73.53%	50	0.00 %	0	68
Clarity of the criteria to be used for committee judgements	1.49 %	1	4.48 %	3	5.97 %	4	32.84%	22	55.22%	37	0.00 %	0	67
User-friendliness of the HFSPO web portal for application reviews	5.88 %	4	5.88 %	4	13.24%	9	33.82%	23	36.76%	25	4.41 %	3	68
Appropriateness of the criteria to be used for committee judgements	1.47 %	1	5.88 %	4	8.82 %	6	30.88%	21	51.47%	35	1.47 %	1	68
The HFSPO staff's support and oversight of the committee meeting(s)	1.49 %	1	1.49 %	1	5.97 %	4	5.97 %	4	83.58%	56	1.49 %	1	67
Logistics and organisation of the committee meeting(s)	1.47 %	1	4.41 %	3	4.41 %	3	8.82 %	6	79.41%	54	1.47 %	1	68
The level of academic expertise represented on the committee	1.47 %	1	2.94 %	2	2.94 %	2	11.76%	8	79.41%	54	1.47 %	1	68
The relevance of the expertise represented in the committee to the pool of applications	1.49 %	1	4.48 %	3	1.49 %	1	38.81%	26	50.75%	34	2.99 %	2	67
The diversity in terms of gender, age, nationality and ethnicity represented on the committee	2.99 %	2	2.99 %	2	8.96 %	6	16.42%	11	67.16%	45	1.49 %	1	67
Available time to discuss all applications as much as was necessary to reach suitable judgements	1.47 %	1	4.41 %	3	8.82 %	6	32.35%	22	52.94%	36	0.00 %	0	68
Guidance, information and processes to identify and manage potential conflicts of interest	1.47 %	1	2.94 %	2	8.82 %	6	16.18%	11	70.59%	48	0.00 %	0	68
The time-window available to prepare for the committee meeting(s)	2.94 %	2	1.47 %	1	7.35 %	5	32.35%	22	55.88%	38	0.00 %	0	68

Appropriateness of the amount of feedback required per application	1.47 %	1	2.94 %	2	7.35 %	5	32.35%	22	55.88%	38	0.00 %	0	68
Feel free to comment on any of the aspects above, or any other structural, cultural or administrative aspects around the HFSP application review committees, particularly if you had any noteworthy positive or negative experiences:													29
												Answered	**68**
												Skipped	**2**

Comments (n = 29)

- 12 committee members had very positive impressions of their experience on the committee.
- Two respondents commented that they were against introducing diversity criteria, as it could hinder the "scientific excellence", and suggested inclusion of diversity criteria may restrict the programme's ability to robustly select the most appropriate research.
- However, two other respondents commented that they would like to see more diversity in those who receive funding. Specifically in the personnel or schools that are funded, and in the geography of the host labs.
- Two respondents commented on certain committee members dismissing ideas of other committee members or applicants, based on their gender (female) and their discipline.
- Five committee members commented on problems with the review criteria. For example they were considered too stringent or subjective, and tensions can arise if two criteria oppose one another.
- Three respondents stated they could use more time for the review process or it could be made more efficient.
- Three committee members commented on the need for more diverse expertise within the committee, or more appropriately matching expert reviewers to their subjects.

Please provide your assessment of how strongly each of the following criteria influenced the judgement and decision-making in the HFSP committee meeting(s) you attended. Please rank each criterion on a scale from 1 to 10, where 1 means 'no influence' and 10 means 'extremely strong influence'.

	1 (no influence)		2		3		4		5		6		7		8		9		10 (extremely strong influence)		Don't know / Not applicable		Total
The feasibility of the proposed research	0.00%	0	1.49%	1	11.94%	8	4.48%	3	14.93%	10	7.46%	5	31.34%	21	19.40%	13	2.99%	2	5.97%	4	0.00%	0	67
The rigour and robustness of the proposed research plan	0.00%	0	0.00%	0	1.49%	1	1.49%	1	13.43%	9	10.45%	7	22.39%	15	28.36%	19	11.94%	8	10.45%	7	0.00%	0	67
The importance of the proposed topic and/or research questions to the wider academic community	0.00%	0	0.00%	0	2.99%	2	0.00%	0	8.96%	6	2.99%	2	14.93%	10	25.37%	17	31.34%	21	13.43%	9	0.00%	0	67
The track record of the applicant(s)	0.00%	0	1.49%	1	1.49%	1	2.99%	2	5.97%	4	11.94%	8	20.90%	14	20.90%	14	22.39%	15	11.94%	8	0.00%	0	67
The reputation, resources and/or facilities of the applicant's/ applicants'	1.49%	1	0.00%	0	5.97%	4	7.46%	5	19.40%	13	11.94%	8	29.85%	20	11.94%	8	5.97%	4	4.48%	3	1.49%	1	67

institution/laboratory																						
The level of interdisciplinarity of the proposed research or team	0.00%	0	2.99%	2	0.00%	0	4.48%	3	5.97%	4	7.46%	5	14.93%	10	23.88%	16	22.39%	15	16.42%	11	1.49%	1	67
Considerations around diversity in terms of, e.g., gender, age or nationality	7.46%	5	10.45%	7	5.97%	4	4.48%	3	22.39%	15	8.96%	6	20.90%	14	10.45%	7	2.99%	2	1.49%	1	4.48%	3	67
The extent to which the proposed work departs from established or conventional methods, approaches or perspectives	0.00%	0	0.00%	0	2.99%	2	1.49%	1	8.96%	6	4.48%	3	8.96%	6	17.91%	12	25.37%	17	28.36%	19	1.49%	1	67
Please note if there were any other criteria not listed above that you see as a major influence on the HFSP committee's judgement and decision-making.																							14
																					Answered	**67**
																					Skipped	**3**

Comments (n = 14)

- Three respondents commented on a need to push for more diversity, such as the geographical region of applicants, specifically promoting the research from underfunded regions. Two committee members discussed that research from these areas could not compete with highly funded research institutes from North America and Europe as they have less research support.
- Three committee members explicitly mentioned that there should be less focus on the reputation of applicants, and two more alluded to this.
- Two committee members called for more information about the level of risk associated with research, while one other respondent commented that the level of risk was clear throughout the review process.
- Two respondents wanted more focus on the creativity of ideas.

To what extent do you judge the review committee(s) to have successfully identified the highest quality applications to be recommended for funding?

Answer Choices	Responses	
Completely	15.15%	10
To a large extent	80.30%	53
To a moderate extent	4.55%	3
Hardly or not at all	0.00%	0

Can't say / no opinion	0.00%	0
	Answered	**66**
	Skipped	**4**

To what extent do you judge the review committee(s) to have successfully identified the most transformative, non-conventional, 'frontier' or transformative applications to be recommended for funding?		
Answer Choices	Responses	
Completely	17.91%	12
To a large extent	65.67%	44
To a moderate extent	14.93%	10
Hardly or not at all	0.00%	0
Can't say / no opinion	1.49%	1
	Answered	**67**
	Skipped	**3**

To what extent do you judge the review committee(s) to have successfully identified applications with especially novel interdisciplinary approaches to be recommended for funding?		
Answer Choices	Responses	
Completely	22.39%	15
To a large extent	44.78%	30
To a moderate extent	29.85%	20
Hardly or not at all	1.49%	1
Can't say / no opinion	1.49%	1
	Answered	**67**
	Skipped	**3**

Please feel free to provide additional comments/explanations on any of the three above questions.	
Answered	**25**
Skipped	**45**

- Out of 15 committee members who commented, 10 said that the review process is the best option for now despite limitations, and leads to excellent projects being funded.
- Four committee members discussed the criteria of the HFSP review process, and commented that some of the goals are conflicting. Similarly, that there may be too many mandatory criteria for applications to fit, which results in excellent proposals being missed. Comments in surveys alluded to a potential bias towards some kinds of research and institutes, resulting in a lack of diversity in the countries funded. It was also commented that due to the number of reviewers, they sometimes struggle to agree.
- Three committee members commented that the review process is quite conservative, and wards "tended to go to the safe bets, to the obvious, least risky candidates". Survey comments suggested that feasibility was difficult to judge and could impact a project's review score. This may reduce the number of "unconventional" projects which are funded.

If there was anything you could change about the application review processes for the HFSP, what would it be?	
Answered	**34**
Skipped	**36**

- 11 committee members commented that they were pleased with the processes and would not change anything.
- Four committee members valued the in-person meetings, and would like those to resume.
- Four committee members mentioned that the panel may lack expertise, for example in data analysis and modelling.

• Seven committee members made comments about amending the questions and topics covered in the applications. This included allowing schematics or videos in the applications, and more information about the long-term challenges to be addressed.

If there was anything you could change about the HFSP awards themselves (ranging from specific award characteristics to the overall types of awards offered), what would it be?(Please assume for the sake of argument that the HFSP's overall budget cannot be changed.)	
Answered	**28**
Skipped	**42**
• 10 committee members commented that they had no concerns or would not change anything. • Six committee members commented on encouraging more diversity within applications. This included diversity in the countries of research (particularly encouraging more research from disadvantaged countries), the size of the labs, and the amount of funding groups already receive. • Two committee members mentioned that it might be beneficial to evaluate the success of funded projects after some time has passed.	

Please feel free to enter any further comments about your experience as a committee member for the HFSP in the box below.	
Answered	**23**
Skipped	**47**
• 21 committee members left very positive comments about HFSP and their experiences. • Four committee members discussed how committed the reviewers and staff at HFSP are.	

A.2.2. Survey of mail reviewers

How many years of full-time professional research experience (excluding PhD study) did you have when you reviewed your first HFSP application?		
Answer Choices	Responses	
0-4 years	0.00%	0
5-9 years	13.24%	9
10-14 years	26.47%	18
15-19 years	22.06%	15
20-24 years	14.71%	10
25-29 years	10.29%	7
30 years or more	13.24%	9
	Answered	**68**
	Skipped	**1**

How many articles in international, peer reviewed academic journals had you published over the course of your career when you reviewed your first HFSP application, either as first-author or co-author? (Please approximate as closely as you can, including research articles and review papers but excluding book reviews and editorials)		
Answer Choices	Responses	
Fewer than 10	5.88%	4
10-24	8.82%	6
25-49	32.35%	22
50-99	25.00%	17
100-199	20.59%	14
200 or more	7.35%	5
	Answered	**68**
	Skipped	**1**

Prior to reviewing HFSP applications, how many individual research funding applications had you reviewed over the course of your academic career? (If you are unsure, please estimate as closely as you can)		
Answer Choices	Responses	
Fewer than 10	25.00%	17
10-24	29.41%	20
25-49	23.53%	16
50-99	13.24%	9
100-199	2.94%	2
200 or more	5.88%	4
	Answered	**68**
	Skipped	**1**

Please indicate your level of satisfaction with the following aspects connected to your HFSP application reviews													
	Very dissatisfied		Somewhat dissatisfied		Neither satisfied or dissatisfied		Somewhat satisfied		Very satisfied		Don't know / Not applicable		Total
Overall ease of the reviewing process	3.45 %	2	1.72 %	1	6.90 %	4	13.79 %	8	72.41 %	42	1.72 %	1	58
User-friendliness of the HFSPO web portal for application reviews	3.45 %	2	3.45 %	2	8.62 %	5	17.24 %	10	65.52 %	38	1.72 %	1	58
Clarity of HFSPO guidance notes and documentation	3.45 %	2	0.00 %	0	3.45 %	2	17.24 %	10	72.41 %	42	3.45 %	2	58
Communication with the HFSPO during the review process (e.g. for problems or queries)	0.00 %	0	0.00 %	0	5.26 %	3	7.02 %	4	47.37 %	27	40.35 %	23	57
Appropriateness of the reviewing criteria	3.45 %	2	0.00 %	0	1.72 %	1	25.86 %	15	67.24 %	39	1.72 %	1	58
Format and sectioning of the application forms	3.45 %	2	0.00 %	0	5.17 %	3	20.69 %	12	68.97 %	40	1.72 %	1	58
Overall length of the application forms	3.45 %	2	1.72 %	1	5.17 %	3	18.97 %	11	68.97 %	40	1.72 %	1	58
Appropriateness of the amount of feedback required from you per application	1.72 %	1	1.72 %	1	3.45 %	2	29.31 %	17	56.90 %	33	6.90 %	4	58
Time window available for you to conduct the reviews	3.57 %	2	0.00 %	0	8.93 %	5	23.21 %	13	62.50 %	35	1.79 %	1	56
Feel free to comment on any of the aspects above, or any other administrative aspects around the HFSP application review process, particularly if you had any noteworthy positive or negative experiences:													12
												Answered	**58**
												Skipped	**11**

To what extent did the applications that the HFSPO provided you for review reflect your research expertise?		
Answer Choices	Responses	
The applications I was given entirely matched my expertise	40.35%	23

The applications I was given mostly matched my expertise	52.63%	30
The applications I was given only partially matched my expertise	3.51%	2
The applications I was given hardly matched my expertise	0.00%	0
Cannot say / no opinion	3.51%	2
	Answered	**57**
	Skipped	**12**

Please provide your assessment of how strongly each of the following criteria influenced your judgements of the applications you reviewed. Please rank each criterion on a scale from 1 to 10, where 1 means 'no influence' and 10 means 'extremely strong influence'

	1 (no influence)		2		3		4		5		6		7		8		9		10 (extremely strong influence)		Don't know / not applicable		Total
The feasibility of the proposed research	0.00%	0	1.75%	1	1.75%	1	5.26%	3	3.51%	2	10.53%	6	19.30%	11	28.07%	16	14.04%	8	12.28%	7	3.51%	2	57
The rigour and robustness of the proposed research plan	0.00%	0	0.00%	0	0.00%	0	0.00%	0	1.75%	1	10.53%	6	14.04%	8	28.07%	16	24.56%	14	17.54%	10	3.51%	2	57
The importance of the proposed topic and/or research questions to the wider academic community	0.00%	0	1.75%	1	5.26%	3	1.75%	1	1.75%	1	10.53%	6	17.54%	10	22.81%	13	17.54%	10	17.54%	10	3.51%	2	57
The track record of the applicant(s)	0.00%	0	0.00%	0	3.51%	2	0.00%	0	5.26%	3	26.32%	15	14.04%	8	21.05%	12	14.04%	8	12.28%	7	3.51%	2	57
The reputation, resources and/or facilities of the applicant's/applicants' institution/laboratory	3.51%	2	0.00%	0	10.53%	6	12.28%	7	19.30%	11	21.05%	12	12.28%	7	12.28%	7	3.51%	2	1.75%	1	3.51%	2	57
The level of interdisciplinarity of the proposed research or team	0.00%	0	1.75%	1	3.51%	2	0.00%	0	3.51%	2	7.02%	4	15.79%	9	28.07%	16	21.05%	12	15.79%	9	3.51%	2	57
Considerations around diversity in terms of, e.g., gender, age or nationality	15.79%	9	7.02%	4	19.30%	11	1.75%	1	14.04%	8	8.77%	5	19.30%	11	7.02%	4	1.75%	1	0.00%	0	5.26%	3	57
The extent to which the proposed work departs from established or	0.00%	0	0.00%	0	1.75%	1	5.26%	3	8.77%	5	10.53%	6	12.28%	7	19.30%	11	17.54%	10	19.30%	11	5.26%	3	57

conventional methods, approaches or perspectives																							
Please note if there were any other criteria not listed above that you see as a major influence on your judgements of HFSP applications																							4
																						Answered	**57**
																						Skipped	**12**

Overall, how would you rate the quality of the HFSP applications you reviewed? Please compare to any reviewing work you may have done for other funding schemes if applicable, or simply judge based on your own standards if not.		
Answer Choices	Responses	
The applications were generally of excellent quality	59.65%	34
The applications were generally of above-average quality	31.58%	18
The applications were generally of average quality	8.77%	5
The applications were generally of below-average quality	0.00%	0
The applications were generally of poor quality	0.00%	0
Cannot say / no opinion	0.00%	0
	Answered	**57**
	Skipped	**12**

Please feel free to enter any further comments about your experience as a reviewer for the HFSP in the box below. Suggestions about how to improve the scheme and review process are also welcome.	
Answered	**13**
Skipped	**56**

- Four respondents thought it would be beneficial to share reviews and final outcomes with other reviewers after the decisions had been made.
- Two respondents praised the HFSP's focus on interdisciplinarity.
- Six respondents commented on how positive their experiences with the HFSP processes were.

Appendix B Interview details

B.1. List of interviewees

Table 7 Interviews with key HFSP individuals

Name	Role at HFSP	Interview date/time	Interviewer
Almut Kelber	Director of research grants	25-04-2022; 13:00 UK time	Peter Kolarz
Armelle Koukoui	Program Awards Officer - Grants	04-05-2022; 09:00 UK time	Laura Sutinen
Barbara Pauly	Director of Fellowships	04-05-2022; 10:00 UK time	Laura Sutinen
Beverley Glover	Chair of the Council of Scientists	27-04-2022; 13:15 UK time	Peter Kolarz
Carine Schmitt (with Marie-Claude Perdigues on request)	Awards officer - Fellowships	26-04-2022; 09:00 UK time	Peter Kolarz & Laura Sutinen
Carole Asnaghi	Programme awards officer - Grants	03-05-2022; 10:30 UK time	Peter Kolarz
Guntram Bauer	Director of Science Policy and Communications	03-05-2022; 15:00 UK time	Peter Kolarz
Marie-Claude Perdigues (with Carine Schmitt on request)	Awards officer - Fellowships	26-04-2022; 09:00 UK time	Peter Kolarz & Laura Sutinen
Masahide Kikkawa	Council of scientists, vice chair	03-05-2022; 09:00 UK time	Peter Kolarz
Pavel Kabat	Secretary general	27-04-2022; 11:00 UK time	Peter Kolarz

B.2. Interview tool

HFSP review

Interview template

Interviewee Name:	
Position (organisation)	
Interview date/time	dd-mm-yyyy; xxxxhrs UK time
Interviewer	[Interviewer name]

Points to make prior to interview start

- The HFSP has commissioned Technopolis to carry out this review
- We have already carried out an online survey of reviewers and committee members of the HFSP. Now we want to follow up with these interviews. The purpose of this interview is to hear your perspective on the instruments and processes of the HFSP (whether you feel they are working well, what challenges you see, what reforms you might like to see), and also to gain your insight into some of the findings yielded by our research so far.
- What you say in this interview will only be reported in aggregate non-attributable form, and the notes to this interview will not be shared with anyone, not even with the HFSP.
- However, we would like to note the names of all our interviewees in the method annex to the final report. In other words: we'd like to report that we spoke to you, but not what you specifically said. Is this ok with you?

Questions:

- Please can you describe your role? What aspects of the HFSP's processes and practices are you most familiar with?

- The HFSP aims to fund research that is of the highest quality; it is meant to be interdisciplinary; it needs to be 'frontier' research; it involves international collaboration; and present a departure from what applicants have done in the past.

  Out of these criteria, which ones are the most important? Do you feel that some carry greater weight than others, both 'on paper' and in practice when applications are reviewed?

- Do you see any challenges or difficulties in trying to do so many different things within one programme?

- Conversely, do you think there is anything the HFSP should do that it is currently not doing?

- Can you comment on the HFSP's significance in the wider international research landscape? To what extent do you consider it to be either duplicative of other schemes or genuinely offering something unique?

- There is a very high demand for HFSP funding – success rates for applicants are low, especially for LoIs. What do you see as the main challenges in having so many applicants for just a relatively small number of awards?

- Do you see any ways to 'manage' demand, i.e. ensuring fewer applicants/LoIs? Is this even a desirable thing to do?

- The overall application and success rate figures suggest some inequitable gender outcomes. Do you have any suggestions why this might be? Has the HFSP tried to solve this or are there any solutions you think could be tried?

- A very operational question: how fit for purpose and how user-friendly do you judge the HFSP's IT system for processing applications and awards? Does it cause any difficulties in your view?

- Have any other operational/procedural challenges arisen that we have not yet discussed? If so, have things been amended in any way to overcome these challenges?

- In summary, what do you see as the main strengths and weaknesses of the scheme?

- Finally, if you could change one thing about the HFSP, what would it be?

Any other points? / final thoughts / thanks.

Appendix C Review of HFSP supporting parties' programmes

In this section we provide analysis of some of the key dimensions of funding schemes in life sciences and especially molecular biology. We note their features and their similarities with and differences from HFSPO schemes, and what can be learned from this to better support the frontier research of the HFSPO. We note that the actual effect of the design and operation of funding schemes upon the research that takes place in terms of focus, content, and outcomes, is not a simple set of relationships: the outcomes of the characteristics of a scheme may not necessarily combine linearly but could do so multiplicatively, i.e., there is interaction between the elements of the funding instrument [predictor variables].

To add to this complexity is a further factor of interaction with other funding schemes, as the report of the ISRC of 2018 has confirmed.[13] Indeed, as the ISRC notes, such interaction is anticipated and can be considered legitimate in many cases.

We also note that some schemes while appearing as grant schemes have fellowship aspects and could be regarded as hybrid in that there are strong fellowship aspects supporting career development as a main objective of the award (fellowship aspect), but also that team building and the involvement of researchers from multiple institutions is allowed and can be resourced under the terms of the award (grant aspect).

We also note the existence of a number of important research actors in a number of countries that support a range of institutionally based staff in conducting research in the field in which HFSPO's schemes provide grants and fellowships. We have made no attempt to investigate such institutes and their practices as their means of funding is not directly comparable with HFSPO, even if their staff are, in some cases, internationally mobile, project-based, and concerned with research of high scientific quality.

Where we have analysed funding information relating to the schemes, we have converted values to USD [to provide a common baseline] using a rate that applied at the start of the phase of the fieldwork of the project [28-01-22].

C.1. Approach

Our initial research scanned the main funding schemes of both grant or fellowship form in the natural, medical and biological sciences from 16 entities [the EU and the HFSPO were included as providers] under which it would be possible to carry out basic research at a frontier level with international partners, to have an emphasis upon interdisciplinarity, and conduct research that was encouraged to be internationally collaborative, and where eligibility rules for inclusion within the scheme could include the movement of individuals between countries. Initial review of the schemes indicated that across this set of providers there were 134 schemes including four of the HFSPO's own. On closer examination of the schemes against these 'Key Match Criteria': [i) permitting interdisciplinary research; ii) international in character; iii) invited applications from those intending to conduct some form of research with 'Frontiers' emphasis; iv) Eligibility for Funding is International] showed insufficient detail for 13 schemes and these were excluded leaving a set of 121 schemes which we analyse below. Of the 121 schemes, 67 were fellowship type schemes and 54 were grant schemes.

[13] Ogilvie, B., Ip, N., Heemskerk, J., Ulfendahl, M., & Westhof, E. (2018). Strategic Report On HFSPO, a Report of an Independent Scientific Review Committee. Retrieved from https://www.hfsp.org/sites/default/files/2019-02/ISRC%20Strategic%20Report.pdf

C.2. Main Features Analysis

An initial correlation analysis of the 121 cases of the relationship between the four characteristics using R[14] suggests a moderate relationship between internationally collaborative research and international eligibility of funding, and a slightly weaker relationship between frontier research and interdisciplinarity. Other correlations suggest no relationships.

The analysis suggests that there are two dimensions to research funding in this area, an interdisciplinary and frontiers research axis and an internationally collaborative and an international eligibility for funding axis. These two aspects are not however, themselves correlated. This is surprising. We might consider that one-way causality from the interdisciplinarity and frontiers axis to the other axis might have obtained, [although not the other way around]. But, as noted, we did not identify either such link.

Table 8 Scheme Key Match Criteria Correlation

	Scheme Features Bivariate Correlation Matrix			
	Interdisciplinary	Frontiers	Internationally Collaborative	Eligibility for Funding is International
Interdisciplinary	1			
Frontiers	0.311	1		
Internationally Collaborative	-0.081	-0.0287	1	
International Eligibility for Funding	-0.043	0.126	0.459	1

We also assessed how common these features were across the 117 schemes [we excluded the four HFSPO schemes] to make a comparison of how important HFSPO schemes were in offering research with these characteristics within the funding landscape. The incidence rates of each feature are shown below separately for the different types of schemes [Fellowships, and Grants/ Fellowships as Grants]. It is clear that the interdisciplinary emphasis is less common amongst fellowship schemes. In this regard therefore, the HFSPO Fellowships stand out significantly as they are two of the very rare cases of fellowships to emphasise this feature.

Table 9 Scheme Key Match Criteria Occurrence by Scheme Type

Scheme Type	**Scheme Key Match Criteria – Occurrence Across 117 Schemes [i.e., excluding HFSPO schemes – 2 Fellowship and 2 Grant and Fellowship/Grant Schemes]**			
	Interdisciplinary	Frontiers	International Collaborative	Eligibility for Funding is International
Fellowships [65 schemes excluding HFSP]	6	35	41	54

[14] RStudio 2022.02.3+492 "Prairie Trillium" Release (1db809b8323ba0a87c148d16eb84efe39a8e7785, 2022-05-20) for Windows

Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) QtWebEngine/5.12.8 Chrome/69.0.3497.128 Safari/537.36

Grants & G/F [52 schemes excluding HFSPO]	20	34	32	32

C.3. Key Matching Features Analysis

We also graphed and tabulated the counts of schemes by the number of Key Match Criteria where the scheme had at least one Key Match Criterion. There were 117 of these schemes in total [we excluded HFSPO schemes in this analysis] of which 65 were fellowship schemes and 52 were grant schemes. As can be seen, it is unusual for there to be schemes with four features [like the HFSPO schemes], suggesting therefore the uniqueness of the HFSPO offering.

Figure 17 Count of Key Match Criteria Excluding HFSPO by Scheme Type

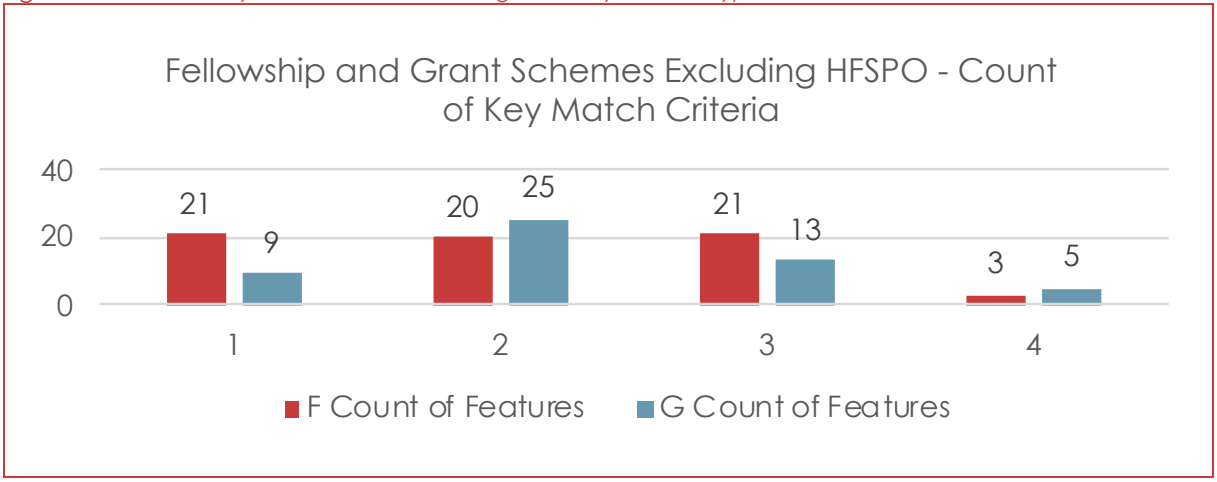


Table 10 Count of Occurrence of Scheme Key Match Criteria by Scheme Type

Scheme Type	Fellowship and Grant Schemes Excluding HFSPO - Count of Key Match Criteria			
	1	2	3	4
F Count of Features	21	20	21	3
G Count of Features	9	25	13	5

C.4. All Matched Schemes

Our analysis of these schemes that met one or more of the Key Match Criteria also included a comparison with the HFSPO fellowship and grant schemes in terms of length of funding, annual amounts of funding, availability of places globally, scheme size, and success rates. Of the 65 other fellowship schemes and the other 52 grant schemes, we noted the following:

- Fellowship duration is on average four years [HFSPO is 3], with a median value of five years; while fellowship funding is on average 319k USD annually, the median value of funding of fellowship schemes is 110k USD annually [HFSPO is 100k USD annually]; the average size of fellowship schemes in terms of awards that funders indicate could be made, i.e., offered (rather than accepted) is 277 although the median is 20, so some very large schemes are raising the average significantly; the overall provision is 3,985 fellowships across all fellowship schemes; the average fellowship success rate is 20% and the median fellowship success rate is 20%. LoI information was not used for analysis purposes as while we had information

on whether LoIs were in use, actual success rates at the different award stages [LoI, Full Application] was not easily accessible.

- Grant duration is on average 4.9 years, with a median value of five years with grant funding on average 718k USD annually although, again, the median value is much lower at 140k USD annually [HFSPO is 500k USD annually]; the average size of grant schemes in terms of allocations is 612 as there are some very large schemes, but the median size of schemes in terms of grants allocated is only 20; the overall provision in terms of grants from those schemes we identified is 23,889; the average fellowship success rate is 26%, the median fellowship success rate is 20%, showing strong similarities with the fellowship schemes.

C.5. Efficiency Issues

The use of LoIs as a means of increasing the efficiency and potentially the effectiveness of the process of application [and peer review] was considered for fellowships and for grants in 117 of the schemes [excluding again the HFSPO schemes]. While amongst both types of awards there was a variety of forms of LoI or pre-qualification, these were in the minority. For fellowships, LoIs were used in seven out of 50 schemes for which information was available [14%] while for grants, eleven schemes used LoIs out of 49 schemes for which information was available [22%]. The difference is not statistically significant. We can now say though that LoIs are in widespread use across schemes in this part of the funding landscape. We have not done analysis of when LoIs were introduced as this information is not always easy to locate. The use of LoIs elsewhere in the research landscape was not investigated.

Table 11 LoI Use by Scheme Type

LoI Use	**Award Type**	
	Fellowship	Grant
Used	7	11
Not Used	43	38
Subtotal	50	49
Information Not Available on LoI Use	*15*	*3*
Total	65	52

C.6. Closely Matched Schemes with HFSPO

We also investigated those schemes that were a very close match to HFSPO in that they *had all four of these characteristics.* There were eight schemes that matched, i.e., that had all four of the key match criteria. These were three fellowship schemes and five grant schemes.

C.6.1.Fellowships

Of the three fellowship schemes that matched the HFSPO on these criteria [the Key Match Criteria], these provided support for three years and offered 60k USD annually [France, Momentum] and 100k USD annually [Republic of Korea, Brain Pool] and one [Australia's 'Investigator Grants' from its National Health and Medical Research Council] provided on average 400k USD annually for five years.

C.6.2. *Grants*

Of the five grant schemes that matched the HFSPO grant schemes on the Key Match Criteria, all provided support for longer than three years and offered substantially greater levels of funding although one scheme's funding arrangements were not available to us. On average, funding was provided over six years. All schemes had international peer review processes in place. There was a mix of application review processes in terms of the number of stages used with the majority using multi-stage review.

C.7. Overall Success Rates by Key HFSPO Features

Where data was available on the size of a scheme and its success rate [74 schemes], we calculated the average success rate for that scheme according to how many of the Key Match Criteria they possessed. This analysis did not include HFSPO schemes themselves and was done to understand how the uniqueness of the features offered by such schemes as HFSPO affects the success rate of applications. The table shown below suggests that the more like HFSPO a scheme is, the lower the success rate.

Table 12 Success Rates of Schemes by Count of Key Match Features

Count of Features	Average Success Rate of Scheme %	Count of Schemes
1	23	12
2	29	30
3	16	26
4	14	6

C.8. Other Features of Relevance

Our detailed examination of the schemes has suggested some features across schemes, including but not confined to HFSPO, that may lead to greater novelty in outputs. We have not of course related these features to publication outputs, outcomes, or wider effects. We note these features that may relate to greater novelty briefly below:

C.8.1. *Application Process*

HFSPO and a small number of other schemes prioritise the details of the work planned by applicants for funding in their application over details of the work to be done. Far more commonly amongst the schemes we reviewed is the practice of requiring applications to provide details of the applicant first and then the details of the work to be done. Australia, Canada, Germany, the USA, and Switzerland each have a small number of schemes where the focus is upon the applicant rather than the application [i.e., the project idea]. We note that some funders' messages are mixed on this point suggesting a focus on the ideas of an application when in fact the evaluation of the application will examine the applicant track record initially.

Generally therefore, proposal evaluation examines both applicant [track record] and project ideas with greater emphasis upon the applicant and their ability to deliver the project.

Double-blind peer review is practiced in some schemes within this funding landscape. The absence of a requirement for data, which is an allowance made to those applying for HFSPO funding, is also made by a very small number of other funders.

C.8.2.Submission Modes and Thematic Programming

HFSPO submission is annual, but other schemes are open continuously while others are open periodically. We noted a wide range of approaches, comprising the following: continuously open, quarterly, annual, biannual, biennial, and periodic / ad hoc. We noted that a small number of schemes were temporarily closed with Covid-19 cited as the reason. We noted the existence within schemes of themed calls, which, while being 'top-down' may however give scope for frontiers and interdisciplinary research of the kind HFSPO supports.

C.8.3.Small Scale of Awards

We note above in our systematic assessment of schemes general patterns in respect of funding, but we should emphasise that a small number of countries have very limited funding amounts even for their most prestigious schemes. Such schemes may not therefore be internationally attractive apart from to a very small group.

C.8.4.Referee Role

In a small number of schemes, but not within HFSPO, our review of schemes showed that referees are encouraged to provide suggestions on the improvement of proposals.

C.8.5.SARS-CoV-2 / Ukraine Disruption

A number of schemes have recently terminated of been suspended owing to the disruption caused by coronavirus. Some schemes have indicated that changes will be made to them as a result of the Ukraine Crisis.

C.8.6.Portfolio Assessment

In a very small number of schemes, funding is awarded on the basis of the set of quality proposals submitted within a particular period or group of calls/rounds rather than on the basis of a ranking of proposals from a single call/round. We term this approach portfolio assessment. It is however rare, the US National Science Foundation being the main example of a funding body which follows this practice in some cases.

C.8.7.Movement Requirement

The requirement for movement of the applicants for funding, which the HFSPO sets as a precondition, is not uncommon in this funding landscape. Many schemes have the feature whereby it is possible to fund an applicant from outside the scheme country either to work outside the scheme country or to move back to the scheme country itself. Such schemes include 'return schemes' of the career development type.

C.9. Country: Australia

C.9.1. Comparator Schemes

Australia possesses two major funding bodies whose schemes support researchers in the same kinds of field which HFSPO supports. These are Australian Research Council and National Health and Medical Research Council. In all, 12 schemes have some overlap with HFSPO's grant and fellowship schemes support in terms of function and objective, but none are close to being identical in that they provide bottom up / response mode funding either at grant level or fellowship with a requirement for international funding and the same locational constraints as HFSPO.

Under the Australian Research council there are two main forms of schemes to support basic research, the **Discovery Programme** and **Linkage Programme** grants. Additionally, the National Health and Medical Research Council also provides funding opportunities some of which approximate to HFSPO schemes. Across the range of schemes available, we note the following that offer some overlap:

Australian Laureate Fellowships; Future Fellowships; Discovery Early Career Researcher Award (DECRA); Discovery Projects; ARC Centres of Excellence; Special Research Initiatives; Investigator Grants; Partnership Projects; Synergy Grants; Development Grants; Ideas Grants; International Bilateral Arrangements, including ERC.

Of these we note close comparators [to the HFSPO Grant or Fellowship Programs] are the **Investigator Grants** of the which can extend up to five years and have around 400,000 USD annually of funding and are intended for significant knowledge gain, which we consider to be emphasizing research at a frontier and involving significant novelty. The other scheme available within the offering from Australian institutions is the new [from 2019] **Synergy Grant Program** which has significant funding, offered for a period of 5 years at a maximum rate of 700,00 USD annually, and is interdisciplinary. None of the schemes offered of either the fellowship or granting schemes require international participation.

C.9.2. Alternative Schemes

We note the scale of the Synergy Grant Programme is larger than anything HFSPO offers, one reason for this being the intended size of the team. In the most recent funding round, it has been an average of eight within the team. This may offer a more significant effort at interdisciplinary work than is available presently within HFSPO structures.

We note that in most cases, schemes fund research for substantial periods of time.

C.10. Country: Canada

C.10.1. Comparator Schemes

Canadian funding in the form of comparator schemes includes the following: Canada Graduate Scholarship (Vanier CGS); Banting Postdoctoral Fellowships; Project Grant Program; Project Grant program [has Early Career Option]; Foundation Grant; Priority-driven research; Postdoctoral Fellowships (PDF); and Discovery Frontiers.

The close comparators for HFSPO schemes are few in number: the Banting Fellowships, which are a form of fellowship programme, are international in that they can facilitate recruitment, i.e., movement internationally to Canada of fellowship winners, or by a Canadian [or other suitably qualified nationality] to an overseas host. The scheme can also include repatriation to Canada. There is no strong emphasis upon interdisciplinarity. Fellowships are for two years and offer 50,000 USD annually. The related Postdoctoral Fellowships are also international,

emphasize interdisciplinarity, and provide funding for two years at a rate of 35,000 USD. A Discovery Frontiers Programme providing support for four years at a rate of 700,000 USD annually is comparable to HFSPO Grant funding and has interdisciplinarity and international collaboration requirements. The Program priorities are however defined in a top down manner and is broader in terms of the scope of the research to be undertaken. LOIs in various form are used in Canada for grants but not for fellowship applications.

C.10.2. Alternative Schemes

We note the readiness of funders in the Canadian case to fund for long periods, for seven years in the case of the Discovery Frontiers and the Foundation Grant.

C.11. Country: France

C.11.1. Comparator Schemes

In France, much competitive international grant funding is provided by the Agence National de Research (ANR), the French National Research Agency. Of the main forms of funding offered [PRC, PRCI, PRCE, JCJC, Flash, MRSEI] all are interdisciplinary with the exception of Flash, which is response to crisis form of funding offer, and only the PRCI supports internationally collaborative work.

The French National Centre for Scientific Research [CNRS], Europe's largest scientific agency and performer of research, has offered its Momentum Grant to young researchers in the form of a three year fellowship with 60,000 USD annually. Calls are however themed, but they are interdisciplinary. The scheme has been discontinued.

The Ministry of Research's Thomas Jefferson Fund supports international collaborative research with the US, but this international research is limited to a two year grant of 20,000 USD annually.

C.11.2. Alternative Schemes

In France, much research takes place intramurally within the laboratory system of the CNRS. Recruitment to CNRS is international and therefore, for some researchers in France and elsewhere in the world, a CNRS position, which is won by means of a competitive examination, is an alternative career path. It may offer therefore employment that provides career stability with some, albeit lower level of independence choice of research topic.

C.12. Country: Germany

C.12.1. Comparator Schemes

Germany's research funding bodies responsible for schemes or facilities which have some comparability with schemes offered by HFSPO or which support research of the kind HFSPO is associated with comprise the Federal Ministry of Education and Research (BMBF), the German Research Foundation ['DFG'], the Helmholtz Association, the Max Planck Society, and Alexander von Humboldt Foundation. These bodies provide a wide range of funding instruments many of which overlap to a considerable degree with HFSPO schemes.

Those which bear closest resemblance are the following:

The BMBF provides a number of centres in which research of the kind supported by HFSPO takes place, the centres are: German Cancer Consortium (DKTK); German Centre for Diabetes Research (DZD); German Centre for Cardiovascular Research (DZHK); German Centre for Infection Research (DZIF); German Centre for Lung Research (DZL); German Centre for Neurodegenerative Diseases (DZNE);

The DfG comparator research funding instruments are across a wide range of types and comprise grants and fellowships. Of grant type are the following: Research Fellowships [recently expired]; Emmy Noether Programme; and Heisenberg Programme. The Emmy Noether is funded at a level where is there is no explicit ceiling, it supports returners to Germany, and has a duration of up to six years. As a returner scheme, is possesses an international dimension but does not require internationalization of the research per se nor interdisciplinarity. The follow-on Heisenberg Programme is for those completing the Emmy Noether Programme award. This follow-on award is funded for four years has no explicit requirement for interdisciplinarity nor internationalization.

Grant type schemes include the following: Individual Research Grants; Reinhart Koselleck Projects; Package Proposals; and Research Units. Of these, the Reinhart Koselleck Projects stand out as an example of a funding scheme that supports very high risk research that may be difficult to fund with other more readily available resources of the DfG or provided by German institutions. The Research Grants [Individual Research Grants] which are for three years have no specific international requirement with the exception the Mercator Grant. There is no requirement for interdisciplinarity. The RKP funds for five years at the very high rate of 1.5 million USD per annum, may be international in terms of team membership, but has no explicit requirement for interdisciplinarity or discipline change. Many other forms of funding exist but all are constrained in some way – infrastructure / they are ex post awards, i.e., they are prizes, they are for forums, or are thematically defined and not therefore bottom up response mode funding.

Helmholtz and Max Planck have large scientific workforces of researchers at different levels of seniority, but they do not offer grants as such, although we note MP offers with the Alexander von Humboldt Foundation, a research award.

The Alexander von-Humboldt Foundation offer a large number of schemes facilitating international research and mobility: Alexander von Humboldt Professorship; Feodor Lynen Research Fellowship; Friedrich Wilhelm Bessel Research Award; Georg Forster Research Award; Georg Forster Research Fellowship; Henriette Herz Scouting Programme; Humboldt Research Award; Humboldt Research Fellowship; International research awards for renowned academics from Germany; Japan Society for the Promotion of Science (JSPS) Research Fellowship; Konrad Adenauer Research Award; Max Planck-Humboldt Research Award; MOST (Taiwan) Research Fellowship; Philipp Schwartz Initiative; and Sofja Kovalevskaja Award. A number of schemes offer significant funding but for short duration. We therefore draw attention to and consider the following as closer to HFSPO awards on account in particular, of the duration of the award and award sizes: Alexander von Humboldt Professorship [4-6 million USD a year for 6 years]; Feodor Lynen Research Fellowship [200,000 for two years] Georg Forster Research Fellowship [90,000 USD for two years]; Max Planck-Humboldt Research Award and the Sofja Kovalevskaja Award [2 million USD for five years.] Of these, all are international in some sense, although none are specifically interdisciplinary. All bring researchers to Germany to continue and to carry out leading research – although the concept of frontier research is not applied in the descriptions we have seen of these schemes.

C.12.2. Alternative Schemes

The German context offers large, well-funded schemes that Reinhart Koselleck Projects and **Alexander von Humboldt Professorship** very well-funded schemes that offer opportunities for high-risk research. They offer the opportunity for international research but do not make it international participation a requirement.

C.13. Country: India

C.13.1. Comparator Schemes

India possesses two organisations that we consider provide schemes that are comparable with the HFSPOs', the Department of Science and Technology [the 'DST'] and the Department of Biotechnology [the 'DB'].

The DST provides a grant, Extra Mural Research Funding (Individual Centric) - now Core Research Grant (CRG), and several fellowships: National Post-Doctoral Fellowship (NPDF); Early Career Research Award (ECRA); SERB Overseas Postdoctoral Fellowship; Indo-U.S. Fellowship for Women in STEMM; Ramanujan Fellowship; Swarnajayanti Fellowships Scheme; and the Bose Fellowship. Of these all have some international dimension, the **SERB Overseas PDF** and the Indo-U.S. Fellowship for Women involve the support of a researcher in an overseas host, but not for longer periods, the first of these supporting for 2 years, the second for six months. All other fellowship schemes provide support for research in India. Three schemes stand out for their length of funding, the Ramanujan Fellowship [which intends to support the return to India of a researcher from outside India], the Swarnajayanti Fellowships Scheme and the Bose Fellowship, which all support for five years. No scheme is specifically interdisciplinary.

The Department of Biotechnology offers the following schemes: DBT Research Associateship (DBT- RA) Programme; Ramalingaswami Re-entry Fellowship; MK Bhan-Young Researchers Fellowship Program; DBT TWAS Full-Time Postgraduate Fellowship; DBT TWAS Sandwich Postgraduate Fellowship; and the DBT-TWAS Postdoctoral Fellowship. The Ramalingaswami Re-entry Fellowship is a re-entry / return to home country scheme and is significant as offering support for five years. None require interdisciplinarity research to take place.

C.13.2. Alternative Schemes

We have not observed in this system schemes or features of schemes that provide a strong basis for further development of HFSPO funding instruments.

C.14. Country: Israel

C.14.1. Comparator Schemes

The Israel Science Foundation is the principal body supporting scientific research but there are a number of other research funding actors with schemes that also cover the life sciences, notably, the Weizmann Institute of Science.

The Israel Science Foundation offers the following schemes all of which are 'remote comparators' compared with HFSPO schemes: Personal Research Grants; The Breakthrough Research Grant (BRG); Joint NSFC-ISF Research Grant; Joint NRF - ISF Research Grant; Israel Precision Medicine Partnership (IPMP); The Joint Canada-Israel Program; Physician-Scientist Research Program; JSPS-ISF Joint Academic Research Program.

These schemes all support research through grants for lengthy periods, only the joint Japan [The Japan Society for the Promotion of Science (JSPS)] programme funds for less than 3 years. Personal Research Grants, which fund for 5 years to around the value of 80,000 USD annually, have an application success rate of 34%.

Of the schemes we have noted in existence in Israel, the BRG, which is intended for senior and established researchers, is very well-resourced for a long period of time.

C.14.2. Alternative Schemes

No specific comment at present

C.15.Country: Italy

C.15.1.Comparator Schemes

In Italy, the Ministry of Universities and Research (MIUR) is the principal research funding organisation. Two schemes that support research Individual Junior Grants/Starting Grants, Individual Senior Grants/Advanced Grants. None are specifically interdisciplinary. The Starting and Advanced Grants are open to people or any nationality. Funding for the schemes on an annualized basis is 250,000 USD and 400,000 for the Starting and Advanced schemes respectively. Proposal submission does not involve an LOI. Proposals are evaluated by the National Evaluation Committee then are subject to independent expert review, and then interview stage or the highest ranking applications.

The Telethon Foundation funds research into disease, treatment and cure. It operates grant scheme, a scheme of the fellowship type, the Telethon Career Award, and a Fondazione Pisana per la Scienza/FT award. All three schemes use the Letter of Intent approach. The grant scheme funds at a rate of 80,000 annually, the remaining two schemes fund at a rate of 40,000 annually.

C.15.2.Alternative Schemes

No specific comment at present

C.16.Country: Japan

6.1.1 Comparator Schemes

In Japan, the Japan Science and Technology Corporation (JST) and the Japan Society for the Promotion of Science (JSPS) are responsible for the main schemes that support HFSPO topics and do so in similar but never exactly the same way as HFSPO. The JST provides a number of schemes within Strategic Basic Research Programs. Where schemes have a defined basic strategic research area in molecular biology, we note them, they are CREST (Core Research for Evolutional Science and Technology), PRESTO, ERATO, and ACCEL. All support research in temporary [5 year – PREST 3 year] periods, The ACT programmes which are a support to a more junior researcher and approximate to a fellowship scheme [ACT-X and ACT-I] do not currently include the HFSPO topic area, so we exclude them here.

The Japan Society for the Promotion of Science (JSPS) schemes are more numerous and comprise grant and fellowship funding. A number of schemes have some pre-definition of the topic area [as HFSPO does, in a sense] but it is whether the schemes have open calls that qualifies them as comparators to HFSPO.

The main schemes offered are:

a) in terms of Grants: i) Grant-in-Aid for Specially Promoted Research; ii) Grant-in-Aid for Scientific Research on Innovative Areas; iii) Grant-in-Aid for Transformative Research Areas; iv) Grant-in-Aid for Scientific Research [range of schemes]; v) Grant-in-Aid for Challenging Research (Pioneering)/(Exploratory). These schemes range from 7 years to 5 years in length and are exceptionally well-funded. On an annual basis, the Specially Promoted Research offers around 1 million USD while the Transformative scheme offers 3 million USD. There are three schemes [schemes iii, iv, and v] which we consider emphasize interdisciplinarity, the Transformative, Scientific Research and Challenging Research Schemes.

b) in terms of fellowship style awards, there are four schemes, the duration of the award is shown in brackets: Grant-in-Aid for Early-Career Scientists [5]; Grant-in-Aid for Research Activity Start-up [2]; Grant-in-Aid for Encouragement of Scientists [1]; Fostering Joint International Research [1-3]; and Home-Returning Researcher Development Research [3].

Overall success rate for application across schemes is noted (Japan Society for the Promotion of Science, 2022) at around 25%.

C.16.1. Alternative Schemes

We note the three grant schemes identified above are well-resourced in terms of annual grant award amounts and grant length.

C.17. Country: New Zealand

C.17.1. Comparator Schemes

In New Zealand, two organisations offer schemes we consider comparable with HFSPO funding are the Health Research Council and the Royal Society of New Zealand. The Health Council currently offers 2022 Explorer Grants, a grant scheme, which is for two years and offers up to 100,000 USD annually, and the 2022 Career Development Awards, a fellowship scheme across five subtypes of which the Sir Charles Hercus Health Research Fellowship is four years and offers the highest levels of funding of around 50,000 USD annually. Fellowships do not stipulate any interdisciplinary requirement, nor do they require international collaboration within the projects that are funded, but they do require the research to aim to be internationally state of the art.

The Royal Society of New Zealand currently offer the following schemes: Fast-Start Standard; Marsden Fund Council Award; Rutherford Discovery Fellowships; Catalyst: Leaders; the JSPS Postdoctoral Fellowship*; Julius von Haast Fellowship Award; International Leader Fellowships bring researchers to New Zealand from other countries [Japan, Germany in the case of the first two, while the International Leader is open as to the country of origin] A James Cook Fellowship is also advertised and provides around 30,000 USD for two years. The Marsden Fund is the main grant support form, and is heavily oversubscribed, with only just over 10% of applications receiving funding (Royal Society of New Zealand, 2018). No special requirement is made for interdisciplinarity in these grants or fellowships. There is a requirement for novelty and 'breaking new ground' in the James Cook award, but this award is not open internationally.

C.17.2. Alternative Schemes

No specific comment at present

C.18. Country: Republic of Korea

C.18.1. Comparator Schemes

In the Republic of Korea, the Ministry of Science and Technology offers around 54 schemes in all for the support of research in the form of grants and fellowships. The majority of fellowship schemes do not emphasize novelty, but a small number do, these being: the Research Staff Program; Research Program for Overlooked Areas; Regional Researcher Program. These programmes may have quite long periods of funding associated with them, the RSP may be up to three years, the others having grant periods as long at 10 years. Funding rates for these three programmes are annually 45,000 USD for the RSP and between 9,000-90,000 USD for the POA and 9,000-45,000 USD for the Regional Researcher Program. A Post-Doctoral Domestic and Overseas Training scheme is also available for three years offering 40,000 USD annually, but it is not clear if this programme requires either interdisciplinarity or a high risk approach to topic

selection. A Brain Pool Award which brings international scholars [also Korean scholars back] to Korea offers 100,000 USD annually for 3 years.

Of the grant programmes which are offered, the Science Research Center (SRC), Convergence Research Center (CRC) and the Basic Research Laboratory Grants explicitly ask for risk and novelty from applicants. These three schemes are substantially funded and for long periods, duration and annual funding amounts are as follows: SRC - 1.8 million USD for up to 7 years; CRC 2 million USD, for up to 7 years; BRLG 455,000 for up to 3 years.

C.18.2. Alternative Schemes

Noticeable is the length of time that the high risk programmes are expected to last.

C.19. Country: Singapore

C.19.1. Comparator Schemes

Two bodies in Singapore offer schemes that approximate to those offered by HFSPO: the National Research Foundation of Singapore and to a lesser extent, the Agency for Science, Technology and Research (A*STAR) which works in close collaboration with Singapore's Institute for Cell and Molecular Biology [ICMB]. The Singaporean Ministry of Health National Medical Research Council also offers a wide range of programmes including grant and fellowship types (Ministry of Health Singapore, 2022). These we consider to be tied to varying degrees to the need for therapeutic outcomes and we do not cover these here as they are more use inspired.

The National Research Foundation provides two fellowship schemes, National Research Foundation Fellowship Programme and National Research Foundation Investigatorship and a grant scheme, Competitive Research Programme, which some may consider as comparable to HFSPO although the CRP, while emphasizing break-through science and is the only scheme emphasizing interdisciplinarity, calls for a use-inspired approach. The CRP uses a LoI and funds for five years at a rate of 1.4 million USD annually. There is though no PI salary support. The Investigatorship is considered to support high risk research.

A*STAR funds widely both institutionally and in the form of competitive grants and fellowships.

C.19.2. Alternative Schemes

No specific comment at present

C.20. Country: Switzerland

C.20.1. Comparator Schemes

In Switzerland, the Swiss National Science Fund [SNSF] is the significant actor in research funding and offers a large number of programmes that have some comparability with those offered by the HFSPO. The following schemes which it offers have some commonalities: Postdoc.Mobility; Project funding; SNSF Advanced Grants; SNSF Swiss Postdoctoral Fellowships (SPF); SNSF Starting Grants 2022; Sinergia; SNSF Consolidator Grants 2022; PRIMA (Promoting Women in Academia); Eccellenza; Practice-to-Science; Ambizione (including Ambizione-PROSPER/SCORE); SPIRIT – Swiss Programme for International Research by Scientific Investigation Teams; International Co-Investigator Scheme; Spark.

Given the extent of Swiss schemes that support research in a comparable way, we have produced a table that facilitates comparison along certain aspects, these being the risk level

of the research to be attempted, annual budget, length, interdisciplinarity and international participation. Where we were able to locate a success rate, we include this.

Scheme	Type	LOI or equivalent used	Size of Awards USD 000 USD	Duration of Awards	Interdisciplinary Criteria	Risk [H=High] NS = Not	Supporting International Collaboration	Open Call and Submission Process	Eligibility and Compliance Aspects Applicants [CH=CH-Based; Int=Internationally	Peer Review [n reviewers, status of experts?]	Success Rate
Postdoc.Mobility	F	No		2 +1 RP		NS	Y	Periodic	CH		48 %
Project funding	G	No	200	4	No	NS	Conditional	Periodic	Int		
SNSF Advanced Grants	G	No	600	5	No	H	Not specific	Periodic	Int		23 %
SNSF Swiss Postdoctoral Fellowships (SPF)	F	No	salary dependent plus project costs	2	No	NS	Not required	Annual Call	Int	Experts, then ranking, random if ties	26 %
SNSF Starting Grants 2022	F	No	400	5	No	H	Not required	Periodic	Int		NA
Sinergia	G	3 Stage: Initial Review, P and P; Committee	800	4	Yes	H	Conditional	Periodic	Int		10 %
SNSF Consolidator Grants 2022	G	Yes	400	5	No	H	Not specific	Periodic	Int		
PRIMA (Promoting Women in Academia)	F	3 Stage: Initial Review, P and P; Committee	160	5	No	NS	Not specific	Periodic	CH		15 %
Eccellenza	F	3 Stage: Initial Review, P and P; Committee	250	5	No	NS	Not specific	Periodic	CH		
Ambizione (including Ambizione-PROSPER/SCORE)	F	3 Stage: Initial Review, P and P; Committee	120	4	No	NS	Not specific	Periodic	CH		20 %
International Co-Investigator Scheme	F	No	>60	<= 4	No	H	Conditional	Periodic	CH		

Spark	G	No	110	1	No	H	Not specific	Periodic	Int	Double blind review

The postdoc mobility scheme is a fellowship type scheme that supports a period of up to two years away from Switzerland and then a return phase of up to a year in which the recipient can establish themselves in the Swiss system. The scheme therefore is international. Success rates are published and indicate around a 50% chance of receiving funding.

The project funding has a success rate of around 34% for a recent round (Swiss National Science Fund, 2022a).

C.20.2. Alternative Schemes

We note that applicants are able to appeal their decision and that process is defined and published on the web site. The Swiss system provides clearer description of its procedures relating to appeal of grant / fellowship decisions.

We note again the emphasis upon the ordering of the process for determining the quality of the application which in the Swiss grant and fellowship application process takes as its first focus the proposal which has been submitted and then moves to consideration of applicant[s] suitability for conducting the research. Please see the box below:

> '6.3 Evaluation criteria
>
> The following criteria will be considered during the evaluation procedure. They will focus on the scientific excellence of the research project and the qualification of the applicant. The criteria will be applied during both evaluation phases based on the documents available (research plan, CV and main scientific achievements, research output):' (Swiss National Science Fund, 2022b)

C.21. Country: United Kingdom

C.21.1. Comparator Schemes

The UK is common with the larger countries has a wide range of supporting organisations, some of which are government, and some charitable foundations. The following are key supporters offering schemes to support research in ways that are comparable to the HFSPO: Biotechnology and Biological Sciences Research Council (BBSRC) [part of and below the UK's Research organisation, UK Research and Innovation - UKRI; Medical Research Council; The Wellcome Trust; and The Royal Society.

The Royal Society's Wolfson Fellowship was very heavily oversubscribed and only 10% of applicants were successful in receiving an award (British Academy, 2022).

Close Equivalent Scheme Name	Scheme General Type	LOI or equivalent used	Size of Awards USD 000 USD	Duration of Award Years	Interdisciplinary Criteria	Risk [H=High] NS = Not Specific]	International Collaboration	Open Call and Submission Process	Eligibility and Compliance Aspects	Peer Review [n reviewers, status of experts?]	Success Rate
BBSRC Discovery Fellowships 2022	F		200	3	N	NS					15 %
Clinician scientist fellowship	F		.8 salary	5	N	NS	Y		clinical roles eligible		17 %
Career development award	F		.8 salary	5	N	NS	Y				17 %
Senior clinical fellowship	F		no limit .5 salary	5	N	NS	Y				17 %
Senior non-clinical fellowship	F		no limit .5 salary	5	N	NS	Y				17 %
Molecular and cellular medicine programme	G		1 .3 million	to 5	N	NS	Y				35 %
Infections and immunity programme	G		1 .3 million	to 5	N	NS	Y				17 %
Molecular and cellular medicine new investigator	G		.6 million	to 5	N	NS	Y				N A
Infections and immunity new investigator	G		.6 million	to 5	N	NS	Y				N A
Wellcome Discovery Awards	G		not salary for lead, numerous allowances	8	N	H	Y			expert and panel	13 %
Wellcome Early-Career Awards	G		100	5	N	NS	Y			expert and panel	13 %
Wellcome Career Development Awards	G		salary plus	8	N	NS	Y			expert and panel	13 %
Starter Grants for Clinical Lecturers	G		40	2	N	NS	Y				13 %
Springboard Awards	G		60	2	N	NS	N			expert and panel	13 %
Royal Society Dorothy Hodgkin	F		60	5	N	H	Y		Host is UK internationally open		13 %

Royal Society Leverhulme Trust Senior Research Fellowship	F		100	1	N	N	N			expert and panel	20 %
Royal Society Wolfson Fellowship	F		80	5	N	NS	N		recruits to UK		10 %
Partnership grant	G	Y			Y	H	N				NA

C.21.2. Alternative Schemes

In the EPSRC Transformative Research activities, we note a new approach which is "a pitch to peers" whereby researchers seek approval for their proposals from other researchers. This is an approach that has been discussed in other contexts, including in an EMBO policy review (Bendiscioli & Garfinkel, 2021, p. 5).

C.22. Country: United States

C.22.1. Comparator Schemes

In the US there are again a number of significant funders who provides schemes that offer comparability with HFPSO awards, these are, the National Institutes of Health, the National Science Foundation, the Howard Hughes Medical Institute, and the Burroughs Wellcome Fund. Across these four major funding bodies we note around 45 schemes that have some significant overlap with HFSPO schemes, and, with each other. The US is particular rich environment in terms of the availability of support mechanisms.

The **National Institutes of Health** represent a very significant funding body for US scientific research and, given the size and budget, this is significant in world terms. NIH has 246 individual programmes across 21 different programme types, although its main activity is within programs spread across the following six main types: Research Grants (R series); Career Development Awards (K series); Research Training and Fellowships (T & F series); Program Project/Center Grants P series); Resource Grants (various series); Trans-NIH Programs. All programmes could facilitate research in the areas on which HFSPO funding is also focused but it is the R Series, the K Series, the T&F Series and the P series where there is more similarity.

Scheme Name	LOI or equivalent used	Size of Awards USD	Duration of Awards	Interdisciplinary Criteria	Frontier / Transformative Dimensions Advertized	International Collaboration	Peer Review [n reviewers, status of experts?]	Demand Rate	Awarded	Success Rate %
NIH Research Project Grant Program (R01)		unlimited	3 to 5 years	No	Yes	No	Peer review then advisory board	32406	6303	19
NIH Small Grant Program (R03):		50000	2 years	No	Yes	No	Peer review then advisory board	2163	491	23

NIH Exploratory/Developmental Research Grant Award (R21)		130000	2 years	No	Yes	No	Peer review then advisory board	12779	2210	17
NIH Pathway to Independence (PI) Award (K99/R00)		100,00 and 249,000	3 to 5 years	No	Yes	No	Peer review then advisory board	1190	299	25
Senior Research Scientist Award (K05)		200000	5 years	No	Yes		Peer review then advisory board	NA	NA	NA
Career Transition Award K22		125000	3 to 5 years	No	Yes	No	Peer review then advisory board	197	40	20
Emerging Global Leader Award K43		100000	3 to 5 years	No		No	Peer review then advisory board	43	9	21
NIH Director's New Innovator Award (DP2)		300000	3 to 5 years	Possibly	Yes			732	59	8
Research Program Project Grant (P01)		2000000	up to 10 years	Possibly	Yes			195	65	33

Success rates were obtained from National Institutes of Health (2022).

The National Science Fund is also the US's significant funder and uses two main schemes, standard grants and fellowships. Two other schemes should be mentioned however, EAGER and RAISE. These are substantially funded, have long duration, and, while limited in terms of a requirement for international collaboration and in terms of funding for such collaboration, a strong emphasis is placed upon the high risk research and interdisciplinarity [EAGER], while RAISE is intended to involve a lower level of risk. We note a high success rate for such applications. Evaluation of NSF applications may be entirely internal. Furthermore, decisions on the award may be taken in light of the overall mix of applications in a particular set. This will be done at the level of a divisional director of NSF. The extent to which this practice operates is unclear from our review.

Close Equivalent Scheme Name	LOI or equivalent used	Size of Awards USD	Duration of Awards	Interdisciplinary Criteria	Frontier / Transformative Dimensions	International Collaboration	Peer Review [n reviewers, status of experts?]	Success Rate
Standard Grant	No	174000	3	No	Not necessarily 'risk'	Yes but no funding	Five stage, including portfolio assessment and risk assessment	28
Early-concept Grants for Exploratory	Form of LOI [pre-proposal]	150000	2	Yes	High risk	Very limited	Can be internal only	30

Research (EAGER) Proposal								
Research Advanced by Interdisciplinary Science and Engineering (RAISE) Proposal	No	200000	5	Yes	Not necessarily 'risk'	Very limited	Can be internal only	30
Post-doctoral Fellow	No	90000	2 – 3	No	Not necessarily 'risk'	Very limited		30

The **Howard Hughes Medical Institute** ['HHMI'] provides a number of programmes and facilities that might support researchers in the same field as HFSPO support. The following schemes have been offered recently Investigator Program, the Hanna H. Gray Fellows Program, the Janelia Research Campus – which is a research centre to which applications could be made, and a small number of international schemes which are in partnership with other bodies. The HHMI's Medically Trained Scientists Program is currently suspended, and its Faculty Scholars Program is now discontinued. Schemes do not fund internationally but the Fellows program can be used to being researchers to the US although US based supervisor is required. Schemes have no explicit focus on interdisciplinarity, but, through for example, the operation of a research centre with different expertise, the opportunity for cross-disciplinary working may be present.

The **Burroughs Wellcome Fund**['BWF'] offers several schemes which are complementary with those offered by HFSPO: Physician-Scientist Institutional Award, the Career Awards at the Scientific Interface, the Postdoctoral Diversity Enrichment Program and the Investigators in the Pathogenesis of Infectious Disease (PATH) program. The first is an institutional grant to support a medical practitioner establishing a research career. The emphasis upon disciplinary switching for this award indicates a focus on interdisciplinarity. Funding is 2.5 million USD in total. The scheme is currently closed [in 2022]. Career Awards at the Scientific Interface provide 100,000 USD annually for five years, have application by way of pre-proposal LOI, but is not interdisciplinary. The Path program however, which is resourced at a level of 100,00 USD annually is both interdisciplinary and frontier / high risk.

C.22.2. Alternative Schemes

In the NSF approach, there is an attempt to take a more global view of grant applications in terms of their impact within a portfolio of research in the field at the time that individual research applications are assessed. NSF is also required by law to assess impacts more broadly. This is sometimes done by relatively small numbers if individuals and not by panels.

C.23. Country: The European Union

C.23.1. Comparator Schemes

We have examined The European Research Council ['ERC'] and the European Molecular Biology Organization ['EMBO'] as the pre-eminent European based funding bodies whose schemes support research in the same areas as HFSPO [EMBO particularly]. All schemes provided have the objective of supporting frontier research. EMBO notes that while the area of research which it was established to fund was regarded was originally regarded as interdisciplinary, over time, and with the development of that area in its own right, the area is

no longer interdisciplinary. EMBO's schemes therefore do not set out to support interdisciplinary research.

ERC Schemes

Close Equivalent Scheme Name	LOI or	Awards 000 USD	Duration of	Interdisciplinar	Frontier /	International Collaboration	Open Call and Submission Process	Eligibility and Compliance Aspects	Peer Review [n reviewers, status of experts?]	Panel Review	Demand Rate	Success Rate
Starting Grants	No	350	5	No	Yes	Yes possible	host org applies	Open	Panels aided by peers	Yes	2932	16
Consolidator Grants		450	5	No	Yes	Yes possible	host org applies	Open	Panels aided by peers	Yes		12
Advanced Grants		600	5	No	Yes	Yes possible	host org applies	Open	Panels aided by peers	Yes		12
Proof of Concept		*150*	*1.5*			*Yes possible*	*commercialization*			*Yes*		
Synergy	Yes	3 million	6	Yes	Yes	Yes possible	large grant multi-site		3 step: triage, full review, interview, then ranking - for funding	Yes		

EMBO Schemes

Scheme Name	LOI or equivalent used	Size of Awards USD	Duration of	Interdisciplinary Criteria	Frontier / Transformative Dimensions Advertized	International Collaboration	Eligibility and Compliance Aspects	Peer Review [n reviewers, status of experts?]	Demand Rate	Success Rate
Postdoctoral Fellowships	3 stages	80000	2	No	Yes	Required		Experts, and panel		15
Young Investigator Programme	2 stages [pre-screen is not of proposal]	15000	2	No	Yes	Required	Limited		600	15
Installation Grants	4 stages	60000	3	No	Yes	Required	Open	Complex four stage process		12
Global Investigator Network	Pre-application screening	series of allowances	4	No	Yes	Required		Experts, and panel		21

C.23.2. Alternative Schemes

Significant here is the use by ERC in common with HFSPO of review of the intellectual content of a proposal before consideration of the applicant's background. The focus of an evaluation

of an application in such organisations is therefore upon the science contained in the application and then, the suitability of the applicant to conduct the research.

C.24. Full list of schemes

Table 13 List of comparator schemes considered by our study

Country/Area	Funding Body	Scheme Name	Scheme Type
Australia	Australian Research Council	Australian Laureate Fellowships	Fellowship
Australia	Australian Research Council	Future Fellowships	Fellowship
Australia	Australian Research Council	Discovery Early Career Researcher Award (DECRA)	Grant
Australia	Australian Research Council	Discovery Projects	Grant
Australia	Australian Research Council	ARC Centres of Excellence	Grant
Australia	Australian Research Council	Special Research Initiatives	Grant
Australia	National Health and Medical Research Council	Investigator Grants	Fellowship
Australia	National Health and Medical Research Council	Synergy Grants	Grant
Australia	National Health and Medical Research Council	Ideas Grants	Grant
Canada	Natural Sciences and Engineering Research Council of Canada	Banting Postdoctoral Fellowships	Fellowship
Canada	Natural Sciences and Engineering Research Council of Canada	Project Grant program	Grant
Canada	Natural Sciences and Engineering Research Council of Canada	Foundation Grant	Grant
Canada	Natural Sciences and Engineering Research Council of Canada	Postdoctoral Fellowships (PDF)	Fellowship
France	Agence Nationale de la Recherche (ANR)	Projet de Recherche Collaborative (PRC)	Grant
France	Agence Nationale de la Recherche (ANR)	Projet de Recherche Collaborative - International (PRCI)	Grant
France	Agence Nationale de la Recherche (ANR)	Projet de Recherche Collaborative - Entreprise (PRCE),	Grant
France	Agence Nationale de la Recherche (ANR)	Jeune Chercheuse-Jeune Chercheur (JCJC)	Fellowship
France	Centre national de la recherche scientifique	Momentum	Fellowship
France	Ministry of Research	Thomas Jefferson Fund	Fellowship
Germany	Deutsche Forschungsgemeinschaft	Walter Bengamin Programme	Fellowship
Germany	Deutsche Forschungsgemeinschaft	Research Fellowships [recently expired]	Fellowship

Country/Area	Funding Body	Scheme Name	Scheme Type
Germany	Deutsche Forschungsgemeinschaft	Emmy Noether Programme	Fellowship
Germany	Deutsche Forschungsgemeinschaft	Heisenberg Programme	Fellowship
Germany	Deutsche Forschungsgemeinschaft	Individual Research Grants	Grant
Germany	Deutsche Forschungsgemeinschaft	Reinhart Koselleck Projects	Grant
Germany	Deutsche Forschungsgemeinschaft	Research Units	Grant
Germany	Deutsche Forschungsgemeinschaft	Clinical Research Units	Grant
Germany	Deutsche Forschungsgemeinschaft	Projects in Priority Programmes	Grant
Germany	Deutsche Forschungsgemeinschaft	Research Grant Program	Grant
Germany	Alexander von Humboldt Foundation	Alexander von Humboldt Professorship	Fellowship
Germany	Alexander von Humboldt Foundation	Feodor Lynen Research Fellowship	Fellowship
Germany	Alexander von Humboldt Foundation	Georg Forster Research Fellowship	Fellowship
Germany	Alexander von Humboldt Foundation	Humboldt Research Fellowship	Fellowship
Germany	Alexander von Humboldt Foundation & Max Planck	Max Planck-Humboldt Research Award	Fellowship
Germany	Alexander von Humboldt Foundation & Max Planck	Sofja Kovalevskaja Award	Fellowship
Germany	Volkswagenstiftung	Freigeist Fellowships	Fellowship
Israel	Israel Science Foundation	Personal Research Grants	Grant
Israel	Israel Science Foundation	The Breakthrough Research Grant (BRG)	Grant
India	Department of Science and Technology	Extra Mural Research Funding (Individual Centric) - now Core Research Grant (CRG)	Grant
India	Department of Science and Technology	National Post-Doctoral Fellowship (NPDF)	Fellowship
India	Department of Science and Technology	Early Career Research Award (ECRA),	Fellowship
India	Department of Science and Technology	SERB Overseas Postdoctoral Fellowship	Fellowship
India	Department of Science and Technology	Indo-U.S. Fellowship for Women in STEMM	Fellowship
India	Department of Science and Technology	Ramanujan Fellowship	Fellowship
India	Department of Science and Technology	Swarnajayanti Fellowships Scheme	Fellowship
India	Department of Science and Technology	Bose Fellowship	Fellowship

Country/Area	Funding Body	Scheme Name	Scheme Type
India	Department of Biotechnology	DBT Research Associateship (DBT- RA) Programme	Fellowship
India	Department of Biotechnology	Ramalingaswami Re-entry Fellowship	Fellowship
India	Department of Biotechnology	MK Bhan-Young Researchers Fellowship Program	Fellowship
Italy	Ministry of Universities and Research (MIUR)	Individual Junior Grants [new programme]	Grant
Italy	Ministry of Universities and Research (MIUR)	Individual Senior Grants [new programme]	Grant
Italy	Telethon	General Grant	Grant
Italy	Telethon	Telethon Career	Fellowship
Japan	Japan Society for the Promotion of Science (JSPS)	Grant-in-Aid for Transformative Research Areas	Grant
Japan	Japan Society for the Promotion of Science (JSPS)	Grant-in-Aid for Scientific Research [range of schemes]	Grant
Japan	Japan Society for the Promotion of Science (JSPS)	Grant-in-Aid for Challenging Research (Pioneering)/(Exploratory)	Grant
New Zealand	Health Research Council	2022 Explorer Grants	Grant
New Zealand	Health Research Council	2022 Career Development Awards	Fellowship
New Zealand	Royal Society of New Zealand	Marsden Fund Council Award	Fellowship
New Zealand	Royal Society of New Zealand	Rutherford Discovery Fellowships	Fellowship
New Zealand	Royal Society of New Zealand	JSPS Postdoctoral Fellowship*	Fellowship
New Zealand	Royal Society of New Zealand	International Leader Fellowships	Fellowship
New Zealand	Royal Society of New Zealand	Fast-Start	Fellowship
New Zealand	Royal Society of New Zealand	James Cook Fellowship	Fellowship
Republic of Korea	Ministry of Science and Technology	Research Staff Program	Fellowship
Republic of Korea	Ministry of Science and Technology	Research Program for Overlooked Areas	Fellowship
Republic of Korea	Ministry of Science and Technology	Regional Researcher Program	Fellowship
Republic of Korea	Ministry of Science and Technology	Science Research Center (SRC)	Grant
Republic of Korea	Ministry of Science and Technology	Convergence Research Center (CRC)	Grant
Republic of Korea	Ministry of Science and Technology	Basic Research Laboratory	Grant
Republic of Korea	Ministry of Science and Technology	Post-Doctoral Domestic and Overseas Training	Fellowship

Country/Area	Funding Body	Scheme Name	Scheme Type
Republic of Korea	Ministry of Science and Technology	Brain Pool (BP)	Fellowship
Singapore	National Research Foundation of Singapore	National Research Foundation Fellowship Programme	Fellowship
Singapore	National Research Foundation of Singapore	Competitive Research Programme	Grant
Switzerland	Swiss National Science Foundation (SNSF)	Project funding	Grant
Switzerland	Swiss National Science Foundation (SNSF)	SNSF Advanced Grants	Grant
Switzerland	Swiss National Science Foundation (SNSF)	SNSF Swiss Postdoctoral Fellowships (SPF) [various schemes]	Fellowship
Switzerland	Swiss National Science Foundation (SNSF)	SNSF Starting Grants 2022	Fellowship
Switzerland	Swiss National Science Foundation (SNSF)	Sinergia	Grant
Switzerland	Swiss National Science Foundation (SNSF)	SNSF Consolidator Grants 2022	Grant
Switzerland	Swiss National Science Foundation (SNSF)	PRIMA (Promoting Women in Academia)	Fellowship
Switzerland	Swiss National Science Foundation (SNSF)	Eccellenza	Fellowship
Switzerland	Swiss National Science Foundation (SNSF)	International Co-Investigator Scheme	Fellowship
Switzerland	Swiss National Science Foundation (SNSF)	Spark	Grant
United Kingdom	United Kingdom Research and Innovation (UKRI)	BBSRC Discovery Fellowships 2022	Fellowship
United Kingdom	United Kingdom Research and Innovation (UKRI)	Clinician scientist fellowship	Fellowship
United Kingdom	United Kingdom Research and Innovation (UKRI)	Career development award	Fellowship
United Kingdom	United Kingdom Research and Innovation (UKRI)	Senior clinical fellowship	Fellowship
United Kingdom	United Kingdom Research and Innovation (UKRI)	Senior non-clinical fellowship	Fellowship
United Kingdom	United Kingdom Research and Innovation (UKRI)	Infections and immunity partnership	Grant
United Kingdom	United Kingdom Research and Innovation (UKRI)	Molecular and cellular medicine partnership	Grant
United Kingdom	United Kingdom Research and Innovation (UKRI)	EPSRC Transformative Research - subsetted	Grant
United Kingdom	Wellcome	Wellcome Early-Career Awards	Fellowship

Country/Area	Funding Body	Scheme Name	Scheme Type
United Kingdom	Wellcome	Wellcome Career Development Awards	Fellowship
United Kingdom	Academy of Medical Sciences	Starter Grants for Clinical Lecturers	Fellowship
United Kingdom	Academy of Medical Sciences	Springboard Awards	Fellowship
United Kingdom	The Royal Society	Royal Society Dorothy Hodgkin	Fellowship
United Kingdom	The Royal Society	Royal Society Leverhulme Trust Senior Research Fellowship	Fellowship
United Kingdom	The Royal Society	Royal Society Wolfson Fellowship	Fellowship
United States	Howard Hughes Medical Institute (HHMI)	Investigator Program	Fellowship
United States	Howard Hughes Medical Institute (HHMI)	Hanna H. Gray Fellows Program	Fellowship
United States	Howard Hughes Medical Institute (HHMI)	Medically Trained Scientists Program	Fellowship
United States	Howard Hughes Medical Institute (HHMI)	Faculty Scholars Program	Fellowship
United States	Howard Hughes Medical Institute (HHMI)	International Programs	Fellowship
United States	National Institutes of Health (NIH)	NIH Research Project Grant Program (R01)	Grant
United States	National Institutes of Health (NIH)	NIH Small Grant Program (R03):	Grant
United States	National Institutes of Health (NIH)	NIH Exploratory/Developmental Research Grant Award (R21)	Grant
United States	National Institutes of Health (NIH)	NIH Pathway to Independence (PI) Award (K99/R00)	Grant
United States	National Institutes of Health (NIH)	Career Transition Award K22	Fellowship
United States	National Institutes of Health (NIH)	Emerging Global Leader Award K43	Fellowship
United States	National Institutes of Health (NIH)	NIH Director's New Innovator Award (DP2)	Fellowship
United States	National Institutes of Health (NIH)	Research Program Project Grant (P01)	Grant
United States	Burroughs Wellcome Fund	Physician-Scientist Institutional Award	Grant
United States	Burroughs Wellcome Fund	Career Awards at the Scientific Interface	Fellowship
United States	Burroughs Wellcome Fund	Postdoctoral Diversity Enrichment Program	Fellowship
United States	Burroughs Wellcome Fund	Investigators in the Pathogenesis of Infectious Disease (PATH) program	Grant
United States	National Science Foundation	Standard Grant	Grant
United States	National Science Foundation	Continuing Grant	Grant

Country/Area	Funding Body	Scheme Name	Scheme Type
United States	National Science Foundation	Early-concept Grants for Exploratory Research (EAGER) Proposal	Grant
United States	National Science Foundation	Research Advanced by Interdisciplinary Science and Engineering (RAISE) Proposal	Grant
United States	National Science Foundation	Ideas Lab Proposal	Grant
United States	National Science Foundation	Post-doctoral Fellow	Fellowship
European	European Research Council	Starting Grants	Grant
European	European Research Council	Consolidator Grants	Grant
European	European Research Council	Advanced Grants	Grant
European	European Research Council	Synergy	Grant
European	European Molecular Biology Organization (EMBO)	Postdoctoral Fellowships	Fellowship
European	European Molecular Biology Organization (EMBO)	Young Investigator Programme	Fellowship
European	European Molecular Biology Organization (EMBO)	Installation Grants	Fellowship
European	European Molecular Biology Organization (EMBO)	Global Investigator Network	Fellowship

C.25. References

- Bendiscioli, S., & Garfinkel, M. (2021). *Dealing with the limits of peer review with innovative approaches to allocating research funding*. Retrieved from
- British Academy. (2022). The British Academy/Wolfson Fellowships 2021-22 Competition. Retrieved from https://www.thebritishacademy.ac.uk/documents/3468/Final_2021-22_BA_Wolfson_Fellowships_Scheme_Guidance_Notes.pdf
- Japan Society for the Promotion of Science. (2022). *Trends in KAKENHI Applications, Adoptions, and Adoption Rate for Main Research Categories*. Retrieved from https://www.jsps.go.jp/english/e-grants/data/award_trends/2-1_r3e.pdf
- Ministry of Health Singapore. (2022). National Medical Research Council Grants. Retrieved from https://www.nmrc.gov.sg/grants/competitive-research-grants/of-irg
- National Institutes of Health. (2022). Research Portfolio On-line Reporting Tools [RePORT] Success Rates. Retrieved from https://report.nih.gov/funding/nih-budget-and-spending-data-past-fiscal-years/success-rates
- Royal Society of New Zealand. (2018). New Marsden Fund grants support innovative research in Aotearoa from atoms to Antarctica's microbes. Retrieved from https://www.royalsociety.org.nz/news/new-marsden-fund-grants-2018
- Swiss National Science Fund. (2022a). 210 million francs for creative research ideas. Retrieved from https://www.snf.ch/en/XndZ2D3snJZ8X0dA/news/210-million-francs-for-creative-research-ideas
- Swiss National Science Fund. (2022b). Horizon Europe Transitional Measures: Call document for SNSF Starting Grants 2022. Retrieved from https://www.snf.ch/media/fr/2xjhYI3BBecsFhEC/call-snsf-stg.pdf#page=12

Appendix D Consultation of supporting parties

We contacted at least one member from each HFSP supporting party (details provided by HFSP) and invited them to submit their views to us on two core questions (see below). Initial invitations were sent on Monday 09 May 2022, with a short reminder to non-respondents sent on Monday 23rd May 2022. The consultation closed on Tuesday 31st May 2022.

We received a total of 15 responses. Following analysis, we note aggregate responses in our report where relevant. We present below the full anonymised text of the invitation message.

Dear [name],

Technopolis has been commissioned to carry out an organisational and process review of the Human Frontier Science Program (HFSP). You likely received a message from the HFSP secretariat last week, notifying you that we will be getting in touch with you in this context.

As part of our review, we would like to collect views on the HFSP from knowledgeable individuals at the HFSP-supporting organisations – including [HFSP supporting party name]. Specifically, we are seeking input on the following two questions:

- **What is the added value of the HFSP's existence to your organisation's funding offer? Does it cover any gaps for life science researchers in your country?**
- **Do you think the HFSP's provision of grants (see details) and fellowships (see details) is the best use of the HFSP's resources? Do you see a case for the HFSP's offer to change, e.g. to provide additional or completely different award types?**

We are not seeking 'official' organisational statements on these questions. Rather, we seek to collect individual views from people who are able to comment. In the first instance, we invite you to give us your view on the two above questions. However, please also feel free instead to forward this request to another individual in your organisation who you deem best suited to provide views.

How to respond:

- The deadline for responses is the end of this month, so Tuesday 31 May 2022
- All responses should be sent by email directly to me ([email address]) – you can simply hit 'reply' to this email
- Responses can be as long or as short as you like: we are happy to accept a few sentences on each of the two above questions in an email, or a Word attachment with a longer more detailed response to each question
- Ideally, we would like responses to address each question in turn. However, if it makes more sense for you to address both questions together, or if you feel you can comment on one of the questions but not on the other, we are also happy to accept responses to that effect as well
- Responses should include the name and the job title/organisational role of the responder

How we will use the responses:

- We will not include individual responses or attributable quotes in our reporting. Any views you share with us will be kept in confidence and not shared with anyone outside the Technopolis study team. We will only report responses in aggregate, non-attributable from. This means we will largely look for common viewpoints across several responses and only report such aggregate findings, with no reference to specific individuals

- We would however like to report the names and roles of all individuals who respond to this consultation as a list in the method annex to our final reports to the HFSP. In short, we would like to report that you participated in the consultation, but not what you specifically said

We would be delighted if you are willing to help us by participating or sending this request to another well-suited individual in your organisation. Should you have any further questions about this consultation or the review more broadly, I am the project manager for this study, and you can contact me any time.

Many thanks and very best wishes,

[sender's details]

Table 14 Respondents to the consultation of supporting parties

Respondent	Position	Organisation	Country
Adrian Mota	Associate vice president	Canadian Institutes of Health Research	Canada
Andrew Mercer	Professor	University of Otago	New Zealand
Anne Kelso	CEO	National Health and Medical Research Council	Australia
Glauco Tocchini-Valentini	Professor	Institute of Cell Biology, University of Rome	Italy
Henriette van Eijl	Head of Unit RTD E5 - Economic and Social transitions	DG RTD	European Commission
Ingrid Ohlert	Head of group, Life Sciences 1	Deutsche Forschungsgemeinschaft	Germany
Jacques Demotes	Chargé de mission, DGRI – SSRI A4 Biologie Santé	Ministry of Higher Education, Research and Innovation	France
Kevin Belanger	Senior Policy Advisor	Natural Sciences and Engineering Research Council of Canada	Canada
Mark Palmer	Director of international relations	Medical Research Council	United Kingdom
Melanie Welham	Executive Chair	Biotechnology and Biological Sciences Research Council	United Kingdom

Respondent	Position	Organisation	Country
Roger Glass	Director, Fogarty International Center & Associate Director for Global Health	US National Institutes of Health	USA
Shigekazu Nagata	Professor	Osaka University	Japan
Suhyun Park	Deputy Director of Multilateral Cooperation Division	Ministry of Science and ICT	Korea (Republic of)
Thomas Werder Schläpfer	Member of the executive management	Swiss National Science Foundation	Switzerland
Torsten Geißler	Head of division 617	Federal ministry of Education and Research	Germany
Yoshinao Mishima	President	Japan Agency for Medical Research and Development	Japan

D.1. Aggregate findings

Q1 – What is the added value of the HFSP's existence to your organisation's funding offer? Does it cover any gaps for life science researchers in your country?

Overall, very similar messages rose from across the pool of responses; HFSP was thought to be a valuable addition to national landscapes for its focus on:

- International/intercontinental collaboration (esp. the lack of any national/continental limitations which national schemes tend to be subject to, because it allows fresh perspectives to come together, and brings researchers to the international forefront of new knowledge)
- Interdisciplinary focus (ideal for new understanding to arise)
- High-risk frontier research (doesn't have much foothold in traditional schemes, often reported to fill a gap)

These characteristics are reportedly extremely difficult to duplicate in full by national agencies, so the HFSP tends to add value to different people for one or another of the above reasons.

These aspects arose across all respondents, but there was some variation by area as to what aspect was emphasised:

- Asian respondents mentioned most the frontier aspect, an opportunity to enthuse early career researchers and the international collaboration
- Euro respondents mentioned the unique combination of interdisciplinarity and internationality, and the prestige of HFSP awards most often
- North Americans emphasised the interdisciplinarity most typically
- Oceanian respondents aligned about the value in frontier research

Q2 – Do you think the HFSP's provision of grants (see details) and fellowships (see details) is the best use of the HFSP's resources? Do you see a case for the HFSP's offer to change, e.g. to provide additional or completely different award types?

There was more variation between the answers to this question. A prevalent rhetoric was that HFSP was doing a good job as it was, but could perhaps emphasise one element or another in their strategy, like even sharper a focus on frontier research and prioritising cross-disciplinary fellowships.

On that note, suggestions for thematic focus points in awards were made. These included awarding non-conventional, strategically relevant research (e.g., systems biology, AI), and keep monitoring the needs of researchers and adjust accordingly (as they did splitting fellowships).

Two points were particularly raised across several continents:

1. Be more mindful about inclusivity in terms of gender, but also geographic locations. Not only are most awards granted to USA and Europe, but fellowships are also hosted mainly in those countries. Also think about ways to balance inclusivity and research excellence. Simply, bring these considerations into play. One respondent included a list of suggested systems to establish diversity, listed below*
2. Manage the hyper-competition, as the low success rates pose problems like discouraging researchers (downside of prestige)

*Attached list of suggestions for ways to enhance inclusivity and diversity among awardees

- Continental quota
- Special consideration for applicants who wish to do their fellowships in regions other than the U.S./Europe.
- "Double-blind evaluation" - i.e. conceal all information (applicant's preferred fellowship location, host researcher, etc.) other than the applicant's research idea.
- Create a separate track to allow new research institutes that are relatively less known to compete with one another for grants or fellowships.

Appendix E HFSP process mapping

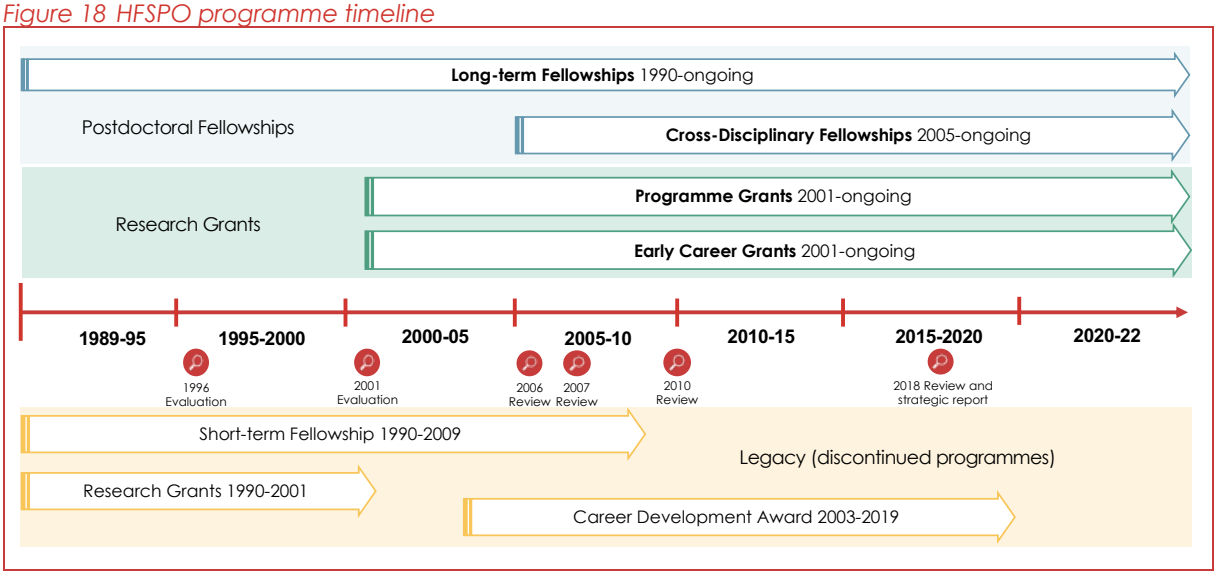
In this section we map out the various established operations and support processes that exist within the International Human Frontier Science Programme Organisation's (HFSPO) funding activities. It involved reviewing 31 documents supplied by HFSPO, a review of HFSPO data and supplementary online searches. This exercise ensures we have a full understanding (and visualisation), step-by-step, of the funding processes of HFSPO, so that we have a solid basis for further assessment of those processes.

Table 15 HFSP programmes (all information up to date as of 2022)

Programme	Brief description and value per award	Awards	Duration
Postdoctoral Fellowships			
Long-Term Fellowships (LTF) Est.1990 - ongoing	For young life scientists within three years of obtaining their PhD (in a biological discipline) who wish to broaden their scientific experience in a foreign laboratory Value: calculated pro-rata based on host country	3197	3 years
Cross-Disciplinary Fellowships (CDF) Est.2005 - ongoing	Specifically for scientists with a PhD in non-biological disciplines to bring new perspectives to research in the life sciences Value: calculated pro-rata based on host country	164	3 years
Research grants			
Programme Grants (RG-P) Est. 2001 - ongoing	For interdisciplinary teams of researchers in different countries at any stage of their careers Value: calculated on team size - USD300k/400k/500k for teams with 2/3/4 members	507	3 years
Early Career Grants (RG-EC) Est. 2001 - ongoing	Grants for interdisciplinary teams of young researchers who are within the first five years of their first independent positions and located in different countries Value: calculated on team size - USD300k/400k/500k for teams with 2/3/4 members	197	3 years
Legacy (discontinued programmes)*			
Research Grants Est.1990 – 2001	Succeeded by RG-Ps and RG-ECs	473	No info
Career Development Award (CDA) Est.2003 – 2019	To help former HFSP fellows establish their own lab (no successor) Value: USD100k per year (Total: USD300k)	244	3 years
Short-term Fellowship Est.1990 – 2009	For scientists who wished to work abroad for a shorter period than LTFs (no successor)	No info	2-12 weeks

Source: HFSPO programme documentation. *The reasons for the discontinuation of these programmes are provided in the 'design and governance' sub-section.

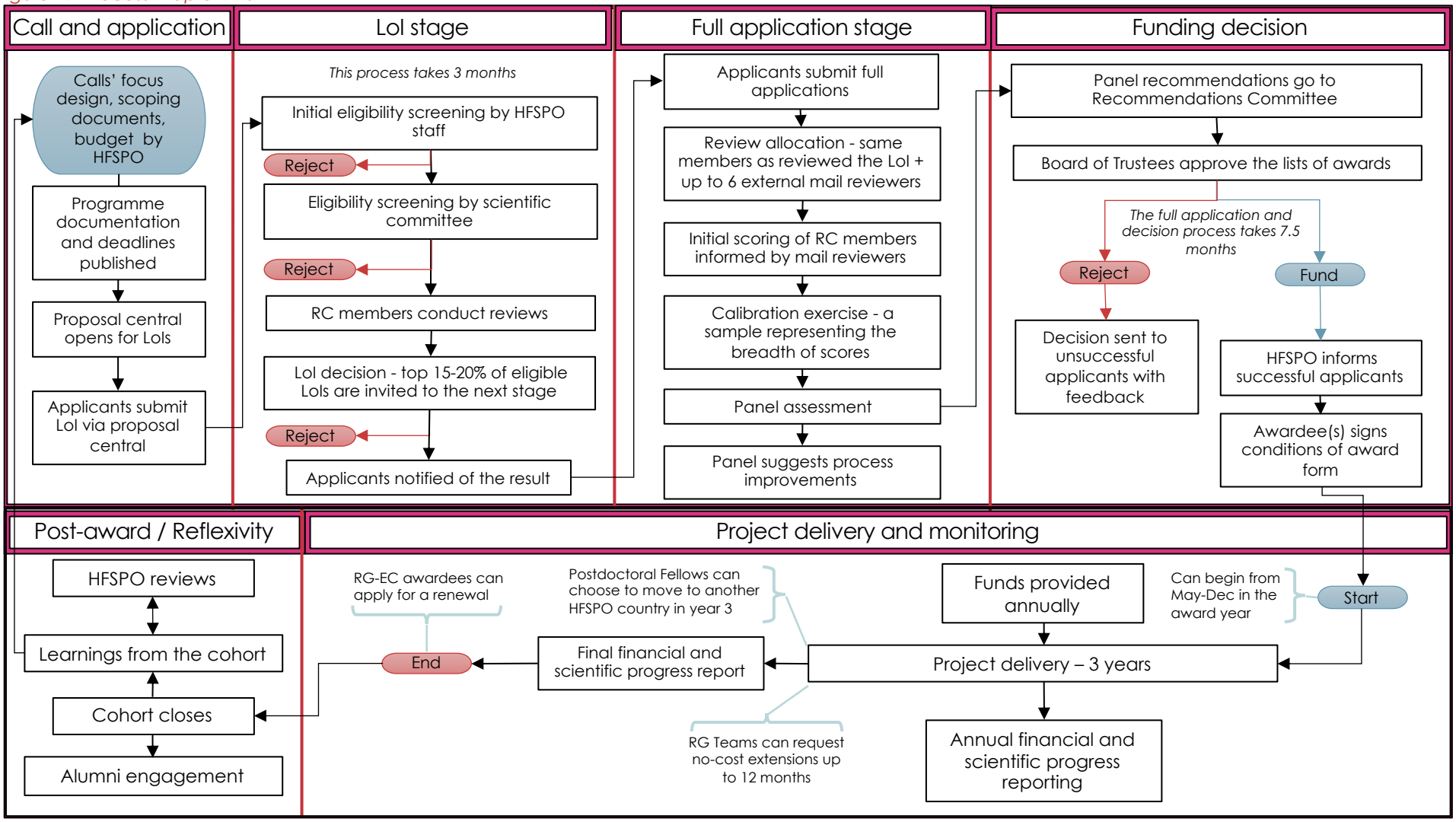
Figure 18 HFSPO programme timeline



Source: HFSPO Programme documentation.

The remainder of this chapter provides descriptions capturing how HFSPO designs, administers and monitors its portfolios. This includes its general approach to these tasks though we indicate where processes differ for specific programmes (e.g. Fellowships vs Research Grants).

Figure 19 Process map of HFSP



E.1. Design and governance

E.1.1. Design

There is little information on the specific design processes of these programmes. As such, the following is a narrative on when the programmes were established as well as when and why certain programmes were discontinued.

Postdoctoral Fellowships - Design

The **LTF** was the first Postdoctoral Fellowship offered by the HFSPO in 1990 along with the **Short-term Fellowship programme**, which also supported scientists who wanted to work abroad but for a shorter period (between two weeks to three months).

The **Career Development Award (CDA)** was introduced in 2003 with the intention of providing an incentive for former HFSP Postdoctoral Fellows to return home and to provide them with research funds to start their independent frontier research laboratories. The decision to launch this program was influenced by the discussion at the end of the 1990s to the early 2000's to counter the 'brain-drain' of young talent moving mostly to the United States and remaining there for much of their professional career.

Only former HFSP Fellows could apply for a CDA and had to do so within two years after the end of their HFSP fellowship (later increased to three years in 2015). In the first years, the award provided flexibility and awardees could choose one of two support mechanisms (funds disbursed over two years at USD90,000 per year or over three years at USD60,000 per year). The standard duration was then set at three years in 2006 and the available funding was increased to USD100,000 per year to help establish fellows as independent investigators/group leaders. In that same year, a CDA holder became a host supervisor for an HFSP fellow for the first time.

In 2019, the HFSPO Board of Trustees decided to terminate the CDA programme. The CDA was established at a time when there were fewer national schemes for life scientists at this early stage of their career. In the late 2010s, many HFSPO Member countries had career development fellowships or similar schemes available and national bodies of many HFSPO Members could support individual investigators and frontier basic life science research. This meant that most former HFSP fellows obtained independent positions without the need of additional HFSP funding. The Board of Trustees concluded that the funds could be better spent on research grants or fellowships, given that HFSPO's funds are limited and success rates for CDA awards were low.

The **CDFs** were introduced in 2005 as a sub-scheme of the LTFs, though the HFSP postdoctoral Fellowship programme always included applicants with a PhD from outside the life sciences before 2005. Often these applicants presented CVs that were very different (e.g. in terms of publishing traditions) from the traditional life scientist. However, their applications performed poorly in the review process compared to the success of other disciplines in transforming the HFSP Research Grant programme. The peer review committee evaluating those proposals was composed of biologists who reported that the applications were difficult to review compared to those from life scientists.

The Board of Trustees decided to introduce the CDF to support postdoctoral researchers, responding to the strategic direction set out by the then Secretary General to bring scientists of different disciplines together for a project in the life sciences (via Research Grants). This sub-programme was intended "*for postdoctoral fellows with a PhD degree in the physical sciences, chemistry, mathematics, engineering, computer sciences etc. who wish to receive training in the life sciences*".

Research Grants - Design

HFSP considers Research Grants an important means to support frontier, transformative discoveries in the life sciences. From 1990-2001, Research Grants was a singular programme. From 2001, it was split into the RG-P and RG-EC programmes. RG-ECs were previously called 'Young Investigator Grants'. The average age of applicants for RG-ECs compared to RG-Ps is lower and the proportion of female scientists is higher. However, early career scientists are also common applicants and awardees in the RG-Ps. The call documents for RGs were updated in 2021 to reflect HFSPO's mission to promote new interdisciplinary collaborations across the world.

During 1990–2000, there were two distinct programs for Brain Science and for Molecular Biology. Applications for these two topics were assessed by two different Review Committees, and the balance between the numbers of projected awarded in both programs was set by the Council of Scientists, with a rule to have 33% of awards in Brain Science. Subsequently, Neurobiology has developed using molecular methods, which were then used in a majority of biological fields. It was decided to merge the two programs and place the strongest emphasis on the interdisciplinarity of the science to be funded (see above). While there are still clear rules regarding scientific domains which are out of scope, the scope has continued to develop, with, for instance, increasing numbers of interdisciplinary, quantitative projects in fields that classically had been considered ecology and out of scope.[15]

HFSPO's Statutes dictate that the most important criteria for RGs are scientific merit, internationality (especially 'intercontinentality') and interdisciplinarity. Yet, in the first decade, less emphasis was placed on interdisciplinarity. This was adjusted starting in 2001; the participation of scientists from outside the life sciences was then monitored over 10 years, based on the titles of applicants' and awardees' institutions. Over the next few years, participation and success of this group increased. At the same time, new interdisciplinary research centres and institutions were established, making HFSPO's push for non-biologists less urgent. Thus, from 2008, on the initiative of the Review Committee, stronger emphasis was again placed on the innovative nature of applications. Non-biologists now make up ~20% of non-biologists among teams.

E.1.2. Governance

The HFSPO has various governing bodies that oversee and deliver on its activities.

Table 16 Summary of governance bodies and their role in the funding process presents descriptions of these bodies and their role in the funding processes. There are other bodies not mentioned here (e.g. treasurer) as their role in funding processes is not significant.

Table 16 Summary of governance bodies and their role in the funding process

Governance body/role[16]	Description
Board of Trustees	The board is responsible for the governance of the organisation. It is made up of representatives from each HFSPO country, the President, Vice-presidents, and a Treasurer. The board can decide to approve or reject the final lists of recommended applications for funding, sent by the Recommendation Committee.

[15] HSFP Scheme History – provided directly to Technopolis by HSFP

[16] Membership of most of these bodies are available in HFSPO's 2020 Annual Report: https://www.hfsp.org/node/74468#book/

President of HFSPO	The President is responsible for the day-to-day management of the organisation and chairs the Board of Trustees. Reports to the Board on the progress of programmes in the form of budgets, a report on scientific achievements and activity plans.
HFSP secretariat and Secretary General	The secretariat is headed by the Secretary General who implements the decisions of the board on which they are a non-voting member. It is responsible for the administration of HFSPO's programmes (e.g. peer review, issuing awards), though it has no influence on who gets funded.
HFSPO Council of Scientists	The Council advises the board of Trustees on the operation of its programmes by providing independent scientific advice. It acts as overseer of the HFSP peer review process by participating as an observer in each RC meeting to monitor due diligence. Assists the Board in how programmes are evaluated
Scientific directors of HFSPO	Sit on a small scientific committee to pre-screen LoIs
Director of Fellowships	Manages the Felowship peer review process, supported by the Fellowships office
Director of Research Grants	Manages the Research Grant peer review process, supported by the Research Grant office
Review Committees (RCs) -. There are currently two RCs: • Fellowship Review Committee[17] • Research Grant Review Committee[18]	24 top scientists as members, which together cover diverse and broad expertise ranging from mathematics and physics to cognitive brain sciences and evolutionary ecology. Since they were established in 1990, they have been strengthened by the addition of physicists, biophysicists, mathematical and computational scientists who were and still are key members, providing expertise for evaluating quantitative biology projects. RCs have at least one member from each member country. RC members are responsible for providing scientific review of LoIs and full applications. RC members also support the pre-screening of LoIs with scientific directors
Research Grant Selection Committee	The Selection Committee consist of 10-12 previous and present RC members that have exhibited a deep understanding of HFSP's mission and aims Supports the Research Grant RC at the LoI stage.
Recommendation Committee	The committee sends the final lists of recommended application to the Trustee Board for the final decision on funding.

E.2. Call, selection and awarding processes

All HFSPO programmes now use a two-stage process: letters of intent (LoIs) and full applications. Research Grants (prior to 2002) and Postdoctoral Fellowships (prior to 2022) used only one stage full applications.[19] The Board of Trustees approved the change because of a risk of review overload. This measure was also intended to lower the effort threshold for potential applicants as it represents a significantly lower time commitment (short LoI first versus full application first).

This sub-section aims to present a unified approach to calls, selection and awarding that is applicable to all HFSPO programmes. Differences per programme are noted.

[17] A list of Committee members as of 2022 can be found here: https://www.hfsp.org/sites/default/files/Sciences/fellows/2022%20Fellowship%20RC%20members.pdf

[18] Membership as of March 2022 - https://www.hfsp.org/sites/default/files/Sciences/Grants/RC%20list.pdf

[19] https://www.hfsp.org/sites/default/files/Sciences/fellows/2022%20LTF%20application%20guidelines.pdf

E.2.1. Call processes

HFSPO's goal across all its programmes is to fund projects that are innovative, original, interdisciplinary and risky rather than safe and predictable. Each call document outlines the mission and objectives of the HFSP more broadly before linking them to each programme type. For example, the Postdoctoral Fellowships fit into the HFSPO's strategy of supporting young scientists to move into new research environments, emphasising the high expectations of the programme. Each document then explains each type of programme (e.g. LTF and CDF) as well as the scientific scope of the programmes: basic research studying fundamental problems on all organisational and trophic levels of life sciences.

The distinguishing features of each programme are explained in each call document, mainly in the context of how HFSPO views its grants as being different to 'traditional' grant programmes. For example, RGs are described as novel and risky, involve only new collaborations, should be transformative for the scientific field, are international and interdisciplinary, and emphasise supporting early career scientists. HFSPO mentions in its guidance documents that traditional funders tend to support less risky research, researchers who have received their support before, and in their home country only. HFSPO welcome exploratory or discovery type applications (do not require preliminary data for the application).

The call documents encourage applicants to propose novel and interdisciplinary approaches involving scientific exchanges across national and disciplinary boundaries. It is understood that such research inherently contains high risks. Therefore, preliminary results are not required, but it is expected that applicants are aware of the risks and have mitigation strategies.

Importantly, HFSPO state in their call documents what they will not fund:

- Projects of a purely applied nature,[20] developing methods of diagnosis or treatment or standard or incremental approaches (e.g. obvious next steps in the field)
- Research not addressing a fundamental biological problem, only addressing agricultural problems, or aimed at analogues or models of biological activity
- Observational projects, systematic screening approaches, or large-scale studies on populations or ecosystems[21]
- Research to support profit-led commercialisation (private sector collaborations are permitted)

A list of characteristics for successful proposals are given in the call documents (e.g. provide a prospect for novel directions in the host laboratory) to help guide applicants in addition to the eligibility and assessment criteria, and abstracts from previous awards.[22] HFSPO emphasise the collaborative and interdisciplinary nature of their RGs, warning against applications where members work in silos.

Detailed process steps for the selection process are explained along with how their LoIs and full applications will be scored by reviewers. Applicants are able to submit questions to the HFSPO (fellow@hfsp.org / grant@hfsp.org) and can access FAQs on the HFSPO website.[23]

The calls are advertised on the HFSPO website to attract applicants.

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[20] i.e. projects of a primarily clinical and pharmaceutical nature.

[21] Though studies of the mechanisms of species-species interactions or their co-evolution are eligible.

[22] https://www.hfsp.org/awardees/awards

[23] https://www.hfsp.org/funding/hfsp-funding/postdoctoral-fellowships / https://www.hfsp.org/funding/hfsp-funding/research-grants#faq

The timings from call to decision is around one year.[24] They are as follows:

- The online system for LoIs opens ten weeks prior to the submission deadline (end of March)
- The time between the LoI deadline and notification of decision (moving to full application or not) takes around three months (beginning of July)
- Applicants then have around two months to submit their full applications (mid-September)
- The time from full application to award notification is seven and a half months (March)

At no point are applicants required to submit budgets. Their awards are calculated on a standard basis (e.g. by number of team members). However, the call documents detail admissible costs as: equipment, materials, services, salaries, communication (e.g. open access), travel and per diem, and overheads (no more than 10% of the costs of the award).

E.2.2. Selection processes

Both LoI and full application stages are peer reviewed via multiple sub-processes.[25]

Stage 1 (Letters of Intent, ~three months)

Applicants are given just under four weeks to submit their LoI via the HFSP application portal.[26] The LoI form asks for a summary of the research plan, Curriculum Vitae, field and title of PhD, publication list, information on host organisation and supervisor (Postdoctoral Fellowships). LoIs are around 6k characters of content (~1,200 words). The next steps of the process are as follows:

- **Pre-review screening**: All LoIs are checked for compliance against the eligibility criteria by HFSPO staff. Then, LoIs are screened by the Selection Committee (three HFSPO scientific directors and two members of the relevant RC) for alignment with the objectives of HFSPO and its programmes. Ineligible LOIs or those not aligned with the scientific scope of HFSP are not sent for review and the applicant is informed.

Table 17 Eligibility criteria

Postdoctoral Fellowships	Research Grants
Applicant must hold a doctorate conferred less than three years prior (research-based Medical Doctorates are applicable).[27] Applicants can only submit one LoI per fellowship per year, previous fellows cannot reapply	The research team must be 2-4 members (five are rarely allowed unless crucial to the interdisciplinarity of the work). Each must have a doctoral degree (conferred no more than ten years ago for RG-EC applicants) and lead a research group (RG-EC applicants must have gained an independent position no more than five years prior). Team members should not have worked together before in any capacity[28] and must propose research significantly different from their own
Applicants must propose a change in country (must be different to the country they did their PhD / postdoctoral work in) and in research topic. Applicants from member HFSP countries can select any country, those not from member countries may	International (and particularly intercontinental) teams are required. A strong case for eligibility must be made for the frontier nature of the work if two members have laboratories in the same country. Teams with two members from the same institution cannot apply (as of 2022). There can only be one Principal Applicant (PA) who must be in a HFSPO country (unless a CDA awardee, but one co-applicant must be in a

[24] HFSPO provides guidance on planning here: https://www.hfsp.org/node/5761

[25] Information from the 2022 application guidelines for LoIs and Full Applications documents.

[26] Via Proposal Central: https://proposalcentral.com/default.asp

[27] Must be in a non-biological discipline if applying for the CDF. This criterion was originally that the degree had to be conferred in the last five years, but was changed to three years in 2002.

[28] There is some allowance for co-authored publications with many authors summarising their field, or very old co-publications in a different field. Three co-publications is considered too many and will reduce funding chances.

Postdoctoral Fellowships	Research Grants
only select HFSP countries as hosts. For-profit hosts are not eligible	HFSPO country). The PA must be from a non-profit academic institution. Team members from for-profit organisations cannot receive funds
Host supervisors cannot be former colleagues/supervisors/co-authors	Applicants can suggest six referees to act as the mail reviewers. They should not have a recent association with these referees
Research topic must be different to applicant's previous work. It must align with the HFSPO's mission and be basic research. Applicants must have at least one lead author publication	Applicants can be named on only one LoI at a time and cannot hold a HFSP award concurrently (apart from a CDA). Previous awardees can reapply only if their awards concluded at least two years prior (e.g. can apply for the 2022 round if the previous award concluded in 2019) and if the new research proposed is distinct enough from the previous award

- **LoI assessment:** Eligible LOIs are assigned to two RC members after the initial screening. Reviewers are asked to use a letter score from A to D[29] to provide a scores for (1) the research proposal and (2) the applicant(s) (letters A-C are considered 'fundable' – see Appendix 1 for a further explanation of what each score means). The suitability of the host laboratory (where Postdoctoral Fellows propose to carry out the research) is assessed only by a Yes/No/Maybe rating. Applications are sent to a third reviewer in cases where the two reviewers score significantly different from each other.
  - **LoI – assessment criteria** (Postdoctoral Fellows only):
    1. Research plan (score from A-D): scientific originality and innovativeness; potential impact on science beyond the immediate field; addresses an important basic biological problem; challenges existing paradigms; the proposal represents a clear departure from the previous research of the applicant
    2. Applicant (score from A-D): acceptance of the risk of a frontier-pushing project; willingness to step beyond their scope of expertise; whether the applicant's background will enhance the project in unique ways; quality of the science produced by the applicant (not the number of publications)[30]
    3. Host laboratory (Yes/No/Maybe): suitable fit for the proposed research
  - The criteria for Grants are similar, however, scores from A to D are given for novelty, interdisciplinarity and team integration, where novelty is the most important criterion
- **LoI decision**: Letter score aggregates per application are used to establish a first ranking of the potential portfolio for stage 2. The call document states that 'the top 15-20% of eligible LOIs' are invited to stage 2 where they can submit a full application. It takes around four months from submission to decision. For grants, a second committee evaluates roughly the upper third of the LoIs (all scored AA, AB, AC, AD or BB plus a number of LoIs scored lower where the written comments seem sound too positive for the given score or where reviewers express that the topic is rather far from their core competence so more evaluation might be needed) and then has a meeting to discuss and decide which teams will be invited to submit full proposals. This selection committee is composed of 10 to 12 present and former members of review committees, each LoI is evaluated by one of them. The committee is chaired by the non-reviewing chair of the review committee.

Stage 2 (Full applications, ~7.5 months):

[29] A = Outstanding; B = Excellent; C = Accomplished; D = Less competitive

[30] HFSP is a signatory to the San Francisco Declaration of Research Assessment (DORA) which asks funder to evaluate research proposals on the basis of their content and not solely by the criterion of Journal Impact Factors).

Full applications are submitted via the same online portal. They contain a summary of the applicants' previous work; the proposed research project; a detailed research plan; why and how the proposed project is a significant change from previous work; why and how the proposed project is of a frontier nature; why the chosen host lab is a good fit and how the applicant will benefit from the host lab (Postdoctoral Fellowships); academic affiliations and ORCID IDs[31] (as of 2022); publication list; recommendation letters from two referees and (for Postdoctoral Fellowships) the host supervisor. Applications are around 7,500-10,000 words long. Host supervisor(s), institutions and referees must have submitted their approval/sections before the applicant can submit their application. Institutions only need to provide a signature (e.g. from provost) to indicate support at this point.

- **Review allocation**: For Fellowships, the full applications are sent to the same two (or three, as of 2020) main RC members who reviewed the LoI, plus to three to six external mail reviewers (international experts in the different fields relevant to each application) who are asked to provide written comments to aid the RC members in their subsequent scoring. For grants, while only two reviewers evaluate each LoI, all full proposals are now evaluated by three reviewers, thus these are not necessarily the same as for the LoI
- **Stage 2 assessment – (1) initial scoring**: The RC members provide scores from 1-10 for their assigned applications, based on a specific set of assessment criteria, and on the evaluations of the mail reviewers (see Appendix 1). HFSPO asks RC members to be aware of the differences between reviewing for a typical national funding body (often emphasising feasibility and translational impacts) and reviewing for HFSP (emphasising originality and acceptance of risk). In assessing CDFs, reviewers are asked to bear in mind that the CDF proposals come from researchers who are entering biology after a PhD in a field outside the life sciences where a lower level of familiarity with biological terminology may be prevalent. A higher level of host-lab involvement in the application is therefore likely and acceptable, and factored into the scoring. Due to these points, a higher level of risk is accepted for CDF applications
  - **Full application - Assessment criteria** (Postdoctoral Fellows only, full description in Appendix A):
    - Research plan (score from 1-10): whether it is innovative, important, potentially transformative; challenges existing paradigms; potential impact beyond the immediate field; risk-profile should be over and above 'safe' national funding schemes[32]; complementarity of applicant and host laboratory talents; a clear departure from the applicant's previous work; applicant's own ideas
    - Applicant (score from 1-10): acceptance of the risk of a frontier-pushing project; willingness to step beyond their scope of expertise; intellectual contribution of the applicant to the proposed project; applicant success potential; complementarity of applicant and the proposes research; contributions to and impact of publications (rather than number of publications and journal impact factor); awards and prizes; level of support in the reference letters[33]; indications of motivation, leadership, vision

[31] ORCID is a way to track researchers and their works using unique IDs.

[32] HFSPO's notion of risk is detailed in applicant guidelines: https://www.hfsp.org/sites/default/files/Sciences/Grants/LI%20Guidelines.pdf

[33] Reviewers are asked to be aware of exaggerated references, potential cultural and gender biases etc.

- Host laboratory (Yes/No/Maybe): suitable fit for the proposed research; applicant opportunities to rise and grow; capability of the host supervisor; whether the supervisor's letter of support shows clear commitment and willingness of mentorship

- **Stage 2 assessment – (2) calibration exercise**: A number of full proposals with different scores will be selected as calibration files to demonstrate a broad range of quality from "outstanding" to "fundable". The aim of the calibration exercise is to introduce RC members (particularly new members) to the special features of the HFSP assessment criteria, and to establish the range of scores that are appropriate to assign. The calibration files are discussed and scored by the RC before the rest of the full proposals
- **Stage 2 assessment – (3) panel assessment**: an RC meeting is held[34] with all members reviewing applications in the current round. For each calibration file as well as for the remaining full applications, the main reviewers present a summary of each application, and of the mail reviews, and state their initial letter and numerical scores. After discussion of each application by the whole RC, the main reviewers announce their final numerical scores. The rest of the RC then provide their own numerical scores for the applications. Members may revise their earlier scores at any time during the meeting
- **Stage 2 decision** - An average score for each application is calculated to generate a ranked list of applications recommended for funding per programme. No subsequent changes to the ranked list of applications are made by HFSPO staff. The list is sent to the Recommendation Committee (common across RGs and Postdoctoral Fellowships) that sends the final recommendation to the Board of Trustees for approval. Selection ends here

E.2.3. Awarding processes

After the Board of Trustees has approved the awards, applicants are notified of the outcome of their applications once (usually by the end of March each year). Due to resource constraints HFSP is unable to provide detailed feedback to unsuccessful applicants.

Successful Fellowship applicants are sent their 'Conditions of Award' form to sign. The most notable of these conditions include:

- The award consists of a living allowance (accounting for cost of living per country), and a research and travel allowance (a small grant).[35] A relocation allowance may also be provided. Awardees can apply for up to three months paid parental leave and can receive a child allowance (introduced in 2005 and 2006 respectively). This financial support was originally only for two years until, in 2001, the support was extended from all three years, and the annual amounts were increased resulting in lower number of awards from 2001 onwards. Annual step increases to the annual amounts were introduced in 2009, and again in 2020 by the ISRC taking Purchasing Power Parity and other funder stipends into account
- HFSP fellows cannot concurrently hold a HFSP award and another paid employment position or another paid fellowship. However, the award can be supplemented from other sources (e.g. from a host supervisor's grant or from institutional funds). HFSP awardees may apply for and hold additional research grants themselves, provided those funds are to assist their HSFP research project

Awardees may then start their project from May to December in the award year.

[34] Usually, the RC meeting is a face-to-face meeting in the HFSPO office in Strasbourg. These have had to be remotely held due to the COVID-19 pandemic, though they may return to in-person in 2022.

[35] All fees per country, including allowances, can be found in the appendix of this document: https://www.hfsp.org/sites/default/files/Sciences/fellows/2022%20LTF%20application%20guidelines.pdf

For Grants, teams receive funding for three years and can allocate the funds between team members as required. Following a decision by the Board of Trustees, the award sum was increased by USD50k per team member to USD300k/400k/500k in total for teams with 2/3/4 members. Two members in one country (or those with a member in a for-profit organisation) constitute as 1.5 members, which impacts on amounts e.g. a team of 2.5 members would receive USD350k.

During the first decade (1990 – 2001) many RG were awarded to large teams of up to 10 members. These more closely resembled networking grants than closely collaborative research grants, and award sums differed vastly between grants. Subsequently, the award sum was set to a fixed amount as mentioned above.

E.3. Delivery and post-award processes

E.3.1. Delivery and project monitoring processes

Applicants receive annual payments over three years, under the condition that an annual scientific report is submitted by the awardees before the second and third payment.

RG teams can request no-cost extensions up to 12 months allowing them to use the funds over a total of four years. A majority of teams presently request such extensions, mainly because it is difficult to exactly plan progress in highly innovative projects with unexpected outcomes but also because hiring personnel with the specific competences required for these projects often takes more time than anticipated.

Postdoctoral Fellows may defer HFSP support after the second year for up to two years (introduced in 2000). The fellow has to remain in the original host laboratory during the deferral period and continue to work on the HFSP funded project while being paid by an alternative source. Only in the third year of the fellowship can fellows choose to continue work in the host laboratory, to return to their or their spouse's/partner's home country (option introduced in 2003), or to move to another HFSPO member country.

HFSP expects fellows to disseminate findings in international, high-quality, peer reviewed open access journals.[36] They may use their grant to fund this (e.g. open access fees). All awardees agree that their submission of manuscripts for publication of their discoveries in journals will not be delayed for more than 45 working days after the manuscript is completed. HFSPO must be acknowledged in these works. HFSPO claims no intellectual or commercial property rights generated by its awardees

HFSPO runs annual awardee meetings and maintains a community of alumni.

E.4. Reflexivity

The HFSPO's Board of Trustees has commissioned a series of independent reviews since its inception to assess its achievements. All of these reviews generally rate the HFSPO and its programmes highly, citing its Nobel Prize winning awardees. The reviews recommend that member countries continue to fund HFSPO (in some cases to increase their contributions) and that HFSPO's approach to interdisciplinary high-risk research should be maintained. Process specific points are identified in the table below.

[36] https://www.hfsp.org/Open-Access-Statement

Table 18 Summary of HFSPO reviews (1996, 2001, 2006-2007, 2010, 2018)

Review	Findings	Process relevant points
1996 Evaluation ARA Consulting and the University of Manchester:	The evaluation of the HFSP (from its pilot phase 1989-1992, and onwards to 1994) concluded that it had an excellent and valuable programme with unique aspects at the time (e.g. international and intercontinental funding) but required more funding from member countries, a point the Board of Trustees mentioned in their 1996 report	The report particularly complimented the peer review process for its robustness compared to other funders'. The most notable of the nine recommendations were for the HFSPO to put processes in place to support younger researchers and to consider extending awards
2001 Review The University of Manchester, KPMG, Professor Akira Goto of Hitotsubashi University	This review focused on the career paths of awardees to assess their scientific achievements. It used primary data collection methods, a bibliometric analysis and a career tracking exercise. It found, like the 1996 evaluation, that the HFSPO offered a unique funding opportunity (compared to others) and that awardees were high achieving post-award	Flexibility in the use of funding was the second most important feature of the Grants programme and rated more highly than other national programmes. Applicants identified the need for more feedback and to improve the visibility of the programme
2006 Review Norwegian Institute for Studies in Innovation, Research and Education	The report assesses policy changes in the HFSP since 2000 and whether the programmes met their aims using surveys and interviews. Again, the report concludes that HFSP fills a unique niche in the funding landscape. The prestige of the HFSPO and its leadership's reflexivity were drivers of this	An alumni network was recommended to be set up, more transparency and feedback to applicants was requested, more funds for supporting young researchers and a need to explore the differences in success rates
2007 Review of the Expert Review Panel	Portfolio changes introduced since the year 2000 were reviewed by a HFSPO panel. The panel reviewed the changes as positive overall and the organisational approach to modifying programmes was praised. Highly rated were the new RG-EC and CDA, merging of the molecular biology and neuroscience programmes, and extensions to fellowships.	The panel recommended that the member countries increase their funding to the HFSPO, due to gaps between country funding targets and their actual contributions. The view was to encourage this support given the success of the programme
2010 Review The Manchester Institute of Innovation Research	This impact review was conducted in preparation for the 2010 Intergovernmental Conference, to assess the performance of HFSP. It used surveys and a bibliometric analysis. They found the HFSP to be unique and the impacts of high quality	Recommendations to increase interdisciplinarity, increase support for CFA and CDA (difficulties in transitioning to independence), establish an alumni network and have voluntary mentors
2018 Review Science Metrix	This report concluded that the HFSP yielded high level scientific outcomes on all indicators, and as compared with other funders' programmes, particularly in terms of interdisciplinarity	The funding amounts and duration of the awards were no longer competitive with other funding programmes
2018 Strategic report Independent Scientific Review Committee	This report was a strategic analysis informed by Science Metrix' work. This strategic report concluded that the HFSPOs programmes were highly regarded, international, synergistic across countries' national funding programmes and sufficiently risky and interdisciplinary	The ISRC recommended that the HFSPO should increase the funding amounts and duration of the programmes, to focus on grants and fellowships and encourage repatriation of Fellows

Source: HFSPO reviews, available at: https://www.hfsp.org/about/strategy/reviews

Appendix F Supplementary data

Breakdown of all Award types by number of applications, awards and success rates 1990-2021

Awards by PI	LoIs	Applications	Awards	LoI to Application conversion rate	Application to Award Success Rate
All Grants 1990-2001	*NA*	*3703*	*529*	*NA*	*14.5%*
*All Grants 2002-2021**	*15257*	*1694*	*651*	*11.1%*	*38.4%*
*Program Grants 2002-2021**	*12151*	*1236*	*466*	*10.2%*	*37.7%*
*Early Career Grants 2002-2021**	*3106*	*458*	*185*	*14.7%*	*40.4%*
All Fellowships		**22181**	**3361**	**NA**	**15.2%**
Long-Term Fellowships		20892	3197	NA	15.3%
Cross-Disciplinary Fellowships		1289	164	NA	12.7%
All Grants and Fellowships		**27578**	**4541**	**NA**	**16.5%**

Gender ratio for all awards

Gender Ratio for all awards**			
PIs by Gender	**Applications**	**Awards**	**Application to Award Success Rate**
Women PIs 1990-2021	**7915**	**1209**	**15.3%**
Women PIs 1990-2001	1546	501	32.4%
Women PIs 2002-2021	6369	708	11.1%
Men PIs 1990-2001	**14636**	**3215**	**22%**
Men PIs 1990-2001	4502	1546	34.3%
Men PIs 2002-2021	10134	1669	16.5%

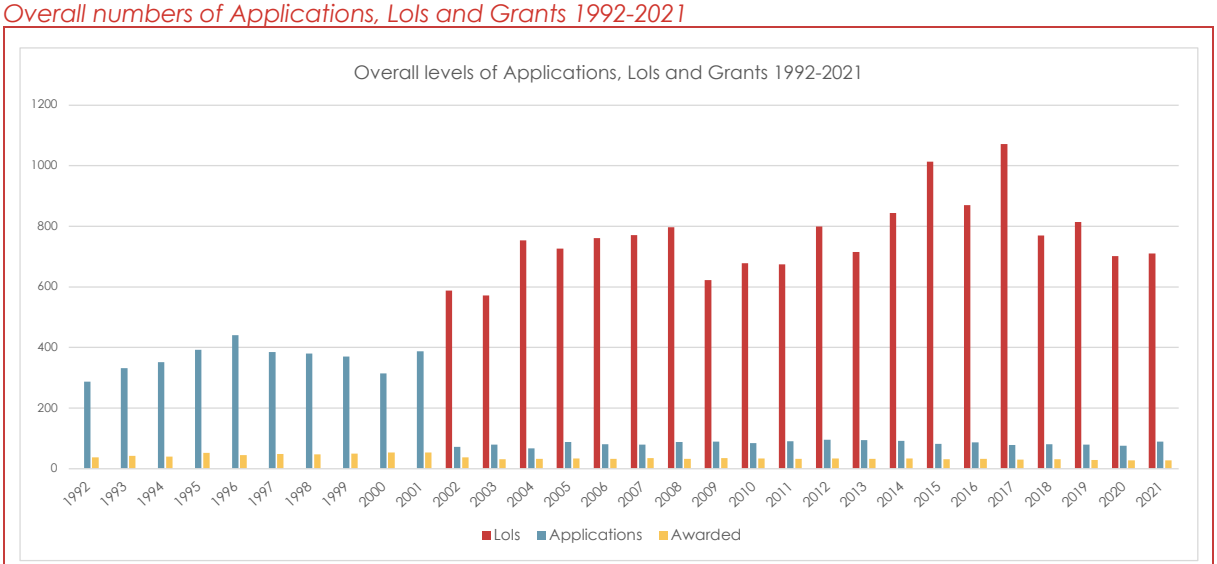
*Grants listed separately for years 1990-2001 and 2002-2021 to showcase the impact of LoIs on success rates

**Ratios calculated based on gender in applications where one was stated

***LoI to Application conversion not relevant in overall numbers, as LoIs are not a part of Fellowship application process

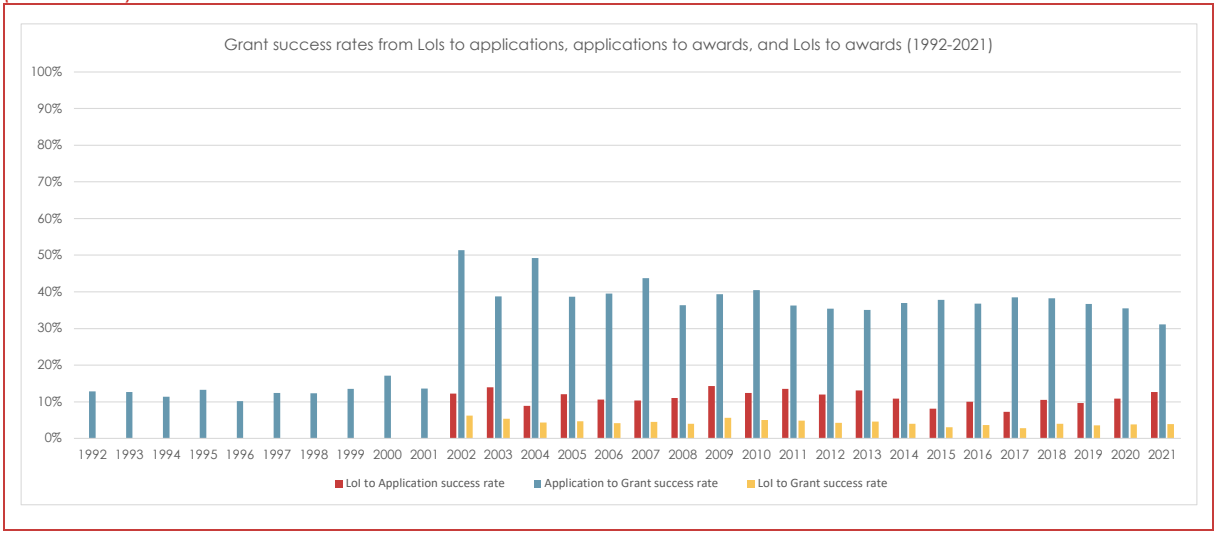
F.1. Grants

Overall numbers of Applications, LoIs and Grants 1992-2021

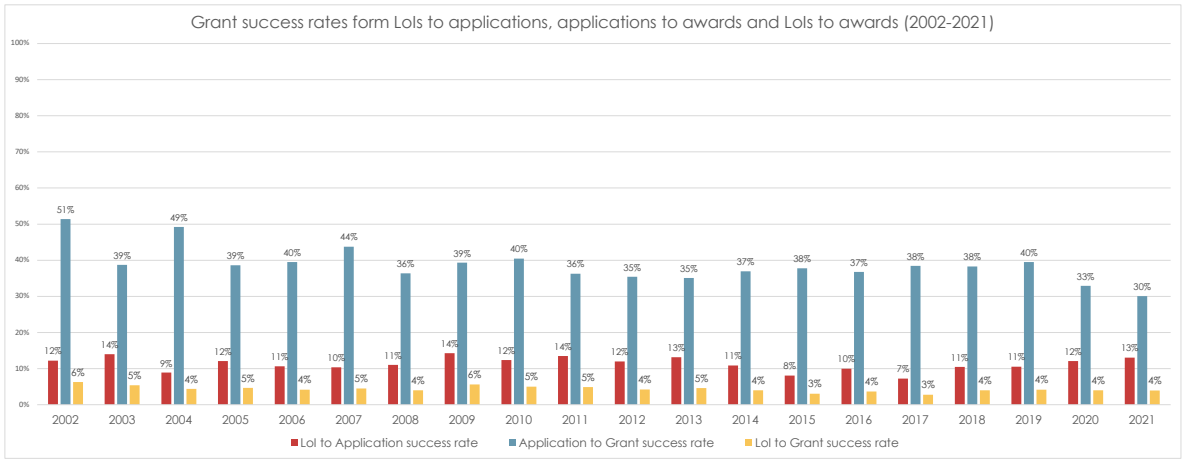


The introduction of LoIs in 2002 appears to have caused a considerable fall in the levels of applications reviewed each year. However, the overall initiative from researchers rose likely due to the less onerous nature of LoIs. LoI application rates have thus far peaked in 2015 and 2017, both years amassing more than 1000 LoIs each. The interest has slightly fallen since, while the levels of applications and awarded Grants have remained fairly steady suggesting a quota for applicants invited to send a formal application.

Grant success rates form LoIs to applications, applications to awards and LoIs to awards (1992-2021)

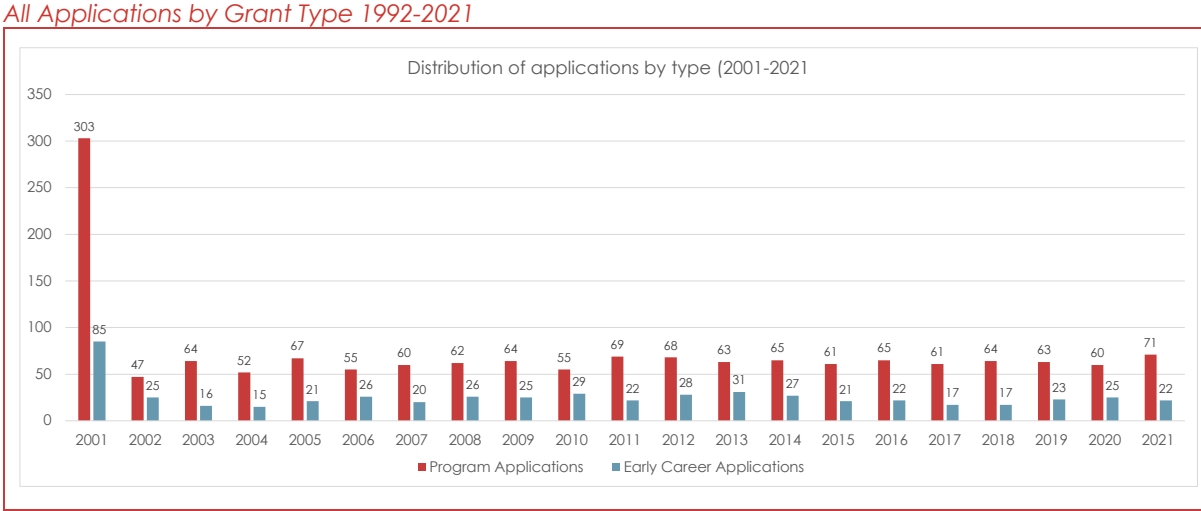


Grant success rates form LoIs to applications, applications to awards and LoIs to awards (2002-2021)



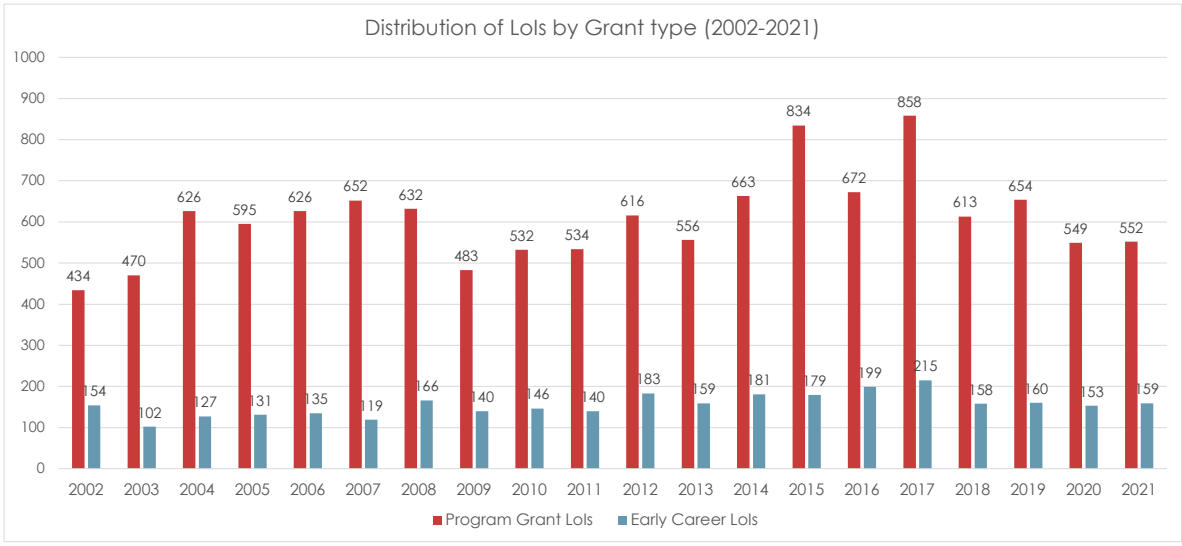
The success rates of Grant applications and Letters of Interest for them have remained relatively stable overall. An exception is presented by the introduction of LoIs, which appears to have led to fewer, but more successful applications.

All Applications by Grant Type 1992-2021

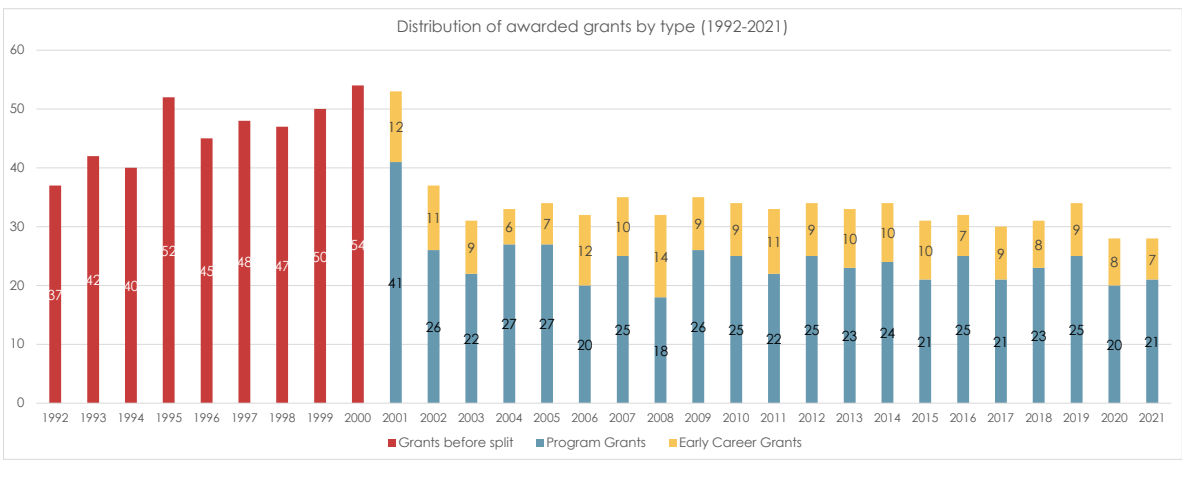


The introduction of Program Grants and Early Career Grants in 2001 saw the applications split into the two types. As mentioned above, the levels of applications have fallen since 2002, and remained steady (particularly compared to the levels of LoIs). Program Grant applications make up a majority of all applications every year, and as seen in Figure 3, Letters of Interest reflect the general popularity for Program Grants compared to Early Career ones.

All LoIs by Grant Type 2002-2021

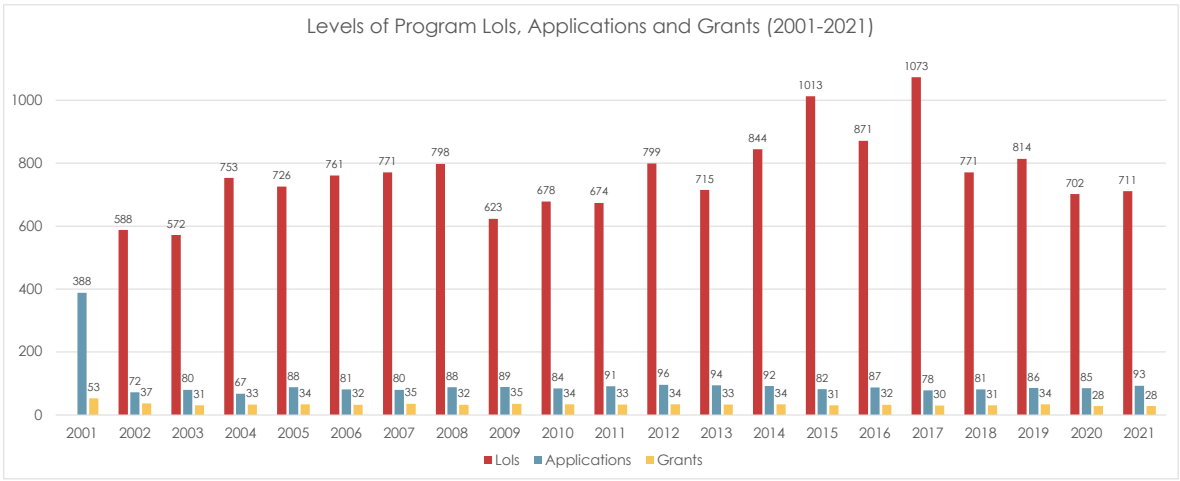


All Awarded Grants by Type 1992-2021

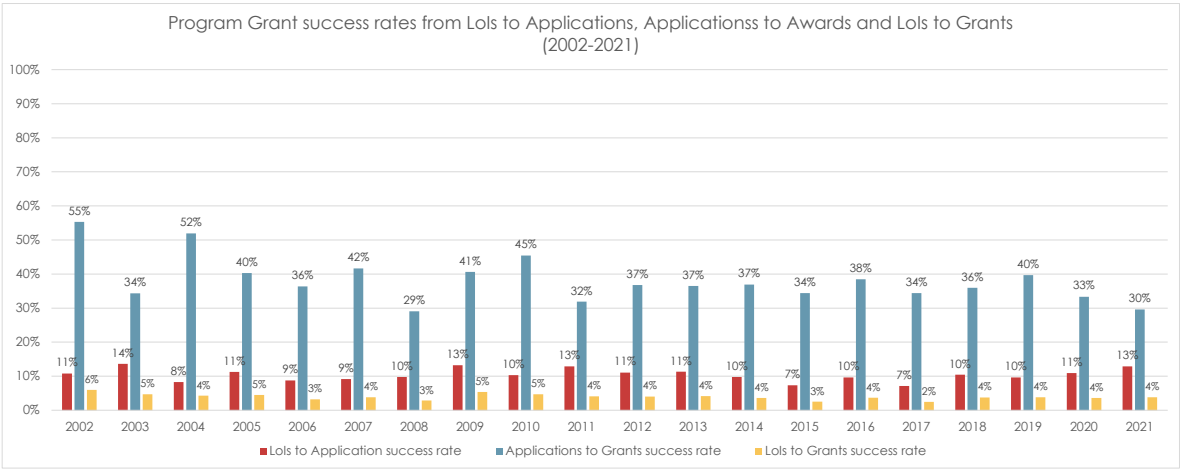


F.1.1. Program Grants

Levels of Program LoIs, Applications and Grants (2001-2021)

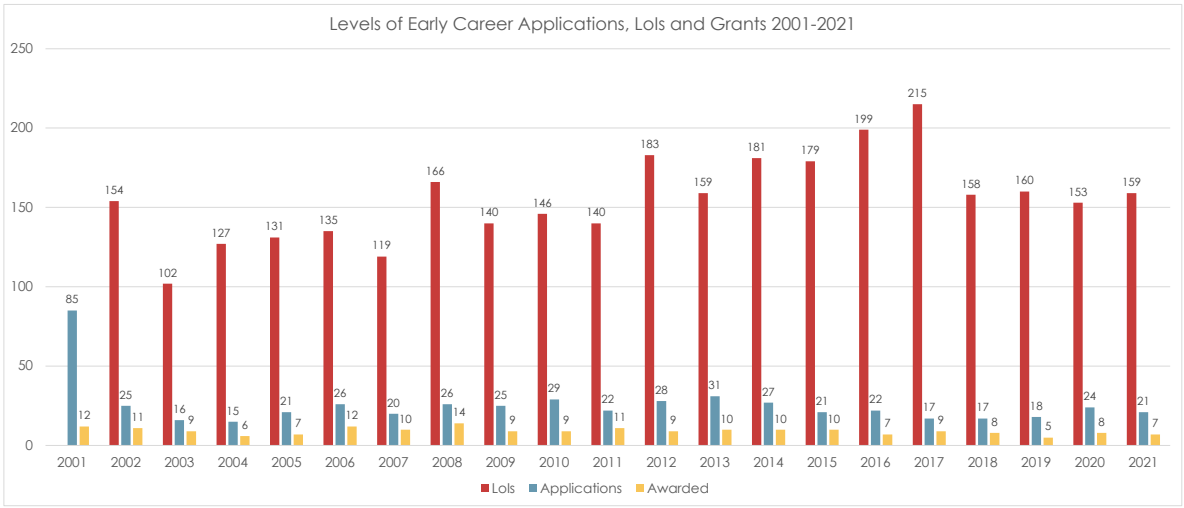


Program grant success rates

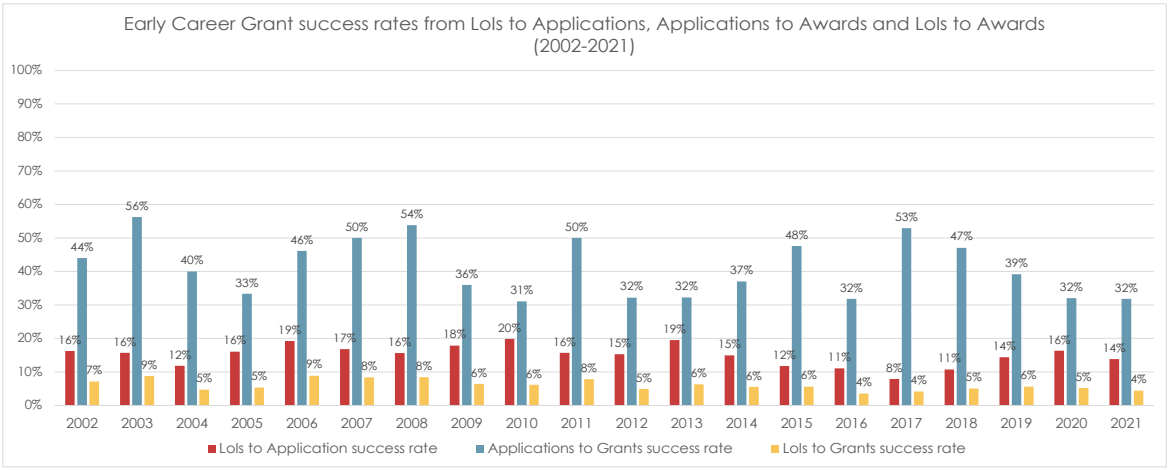


F.1.2. Early Career Grants

Early career grant applications and award numbers



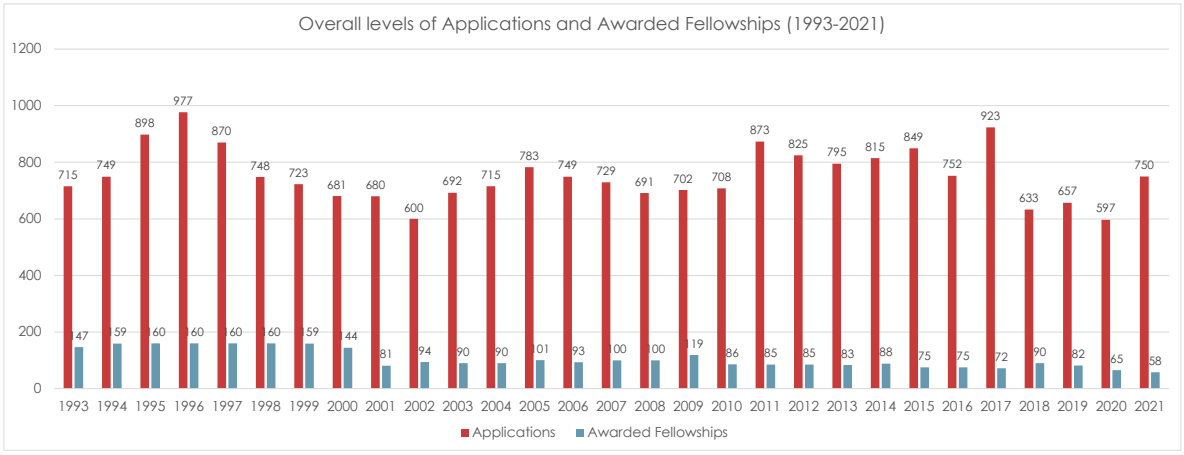
Early career grant success rates



F.2. Fellowships

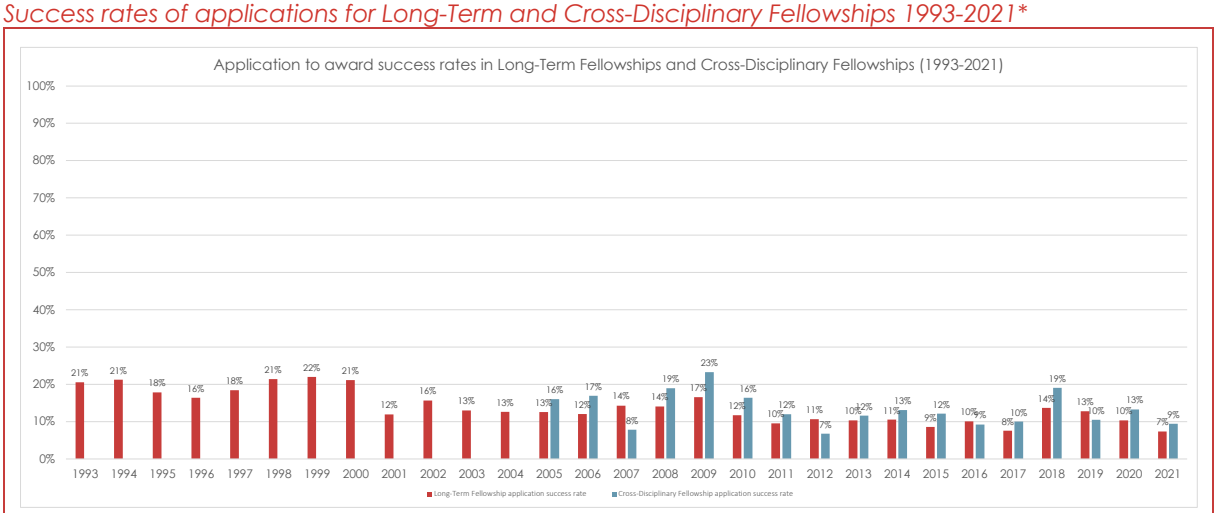
F.2.1. All Fellowships

*Overall levels of Fellowship Applications and Awarded Fellowships 1993-2021**

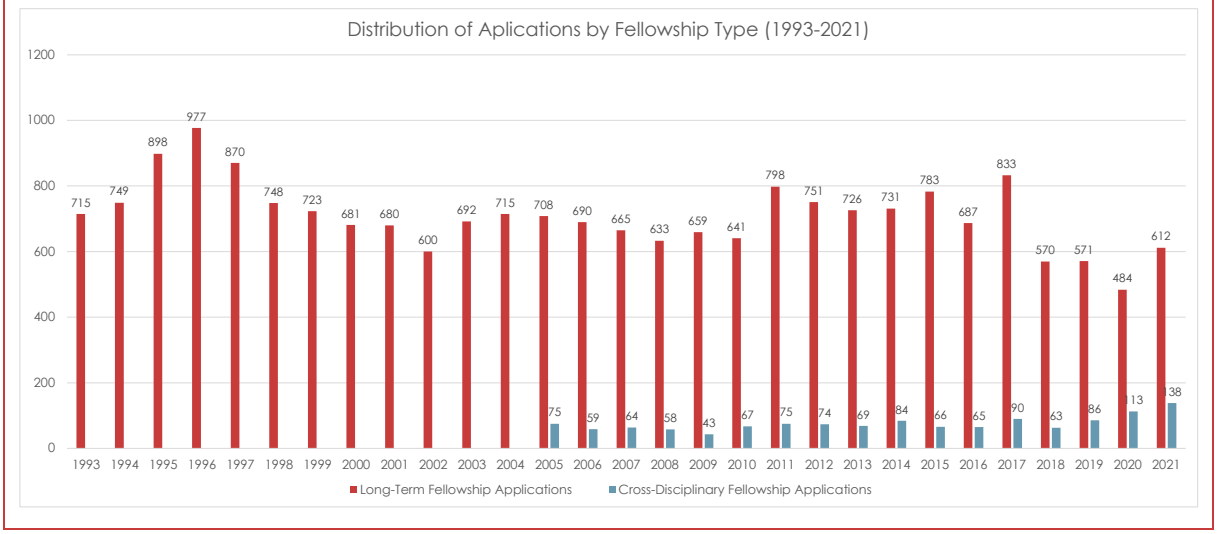


*analysis left out years 1990-1992 as data seemed faulty

*Success rates of applications for Long-Term and Cross-Disciplinary Fellowships 1993-2021**

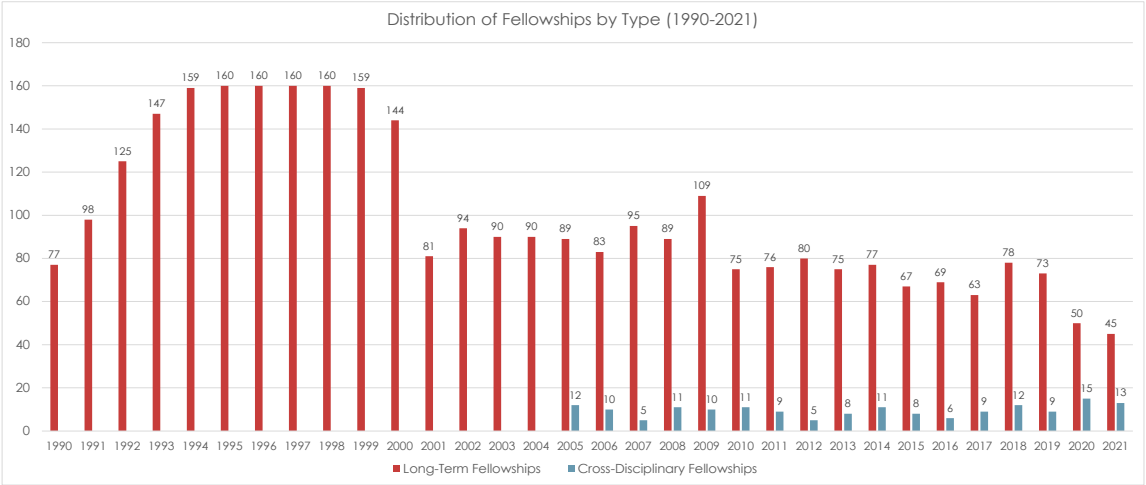


*Fellowship Applications by Fellowship type 1993-2021**



*analysis left out years 1990-1992 as data seemed faulty

Distribution of Awarded Fellowships by Fellowship type 1990-2021

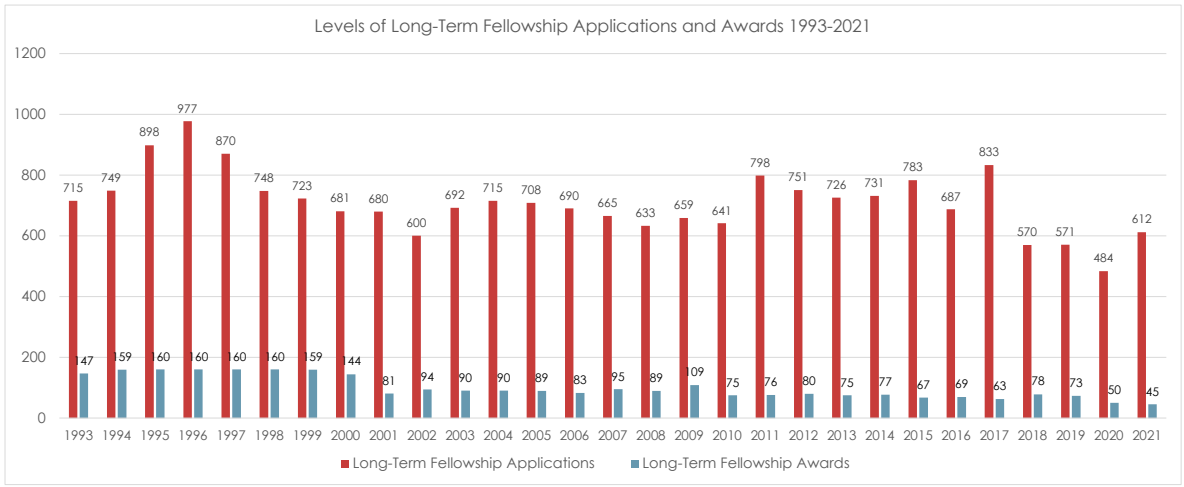


Both, application and award levels show a notable preference for Long-Term Fellowships, although the gap between the types in terms of awarded Fellowships has reduced in the 2020's, and the overall level of awarded Long-Term Fellowships has been at a slow decline since 2009. This reflects the levels of applications for Long-Term Fellowships which fell under 600 per year for the first time in 2017 followed by a slight increase in applications for Cross-Disciplinary Fellowships from 2019 onwards.

The overall level of awarded Fellowships also dropped in 2001 compared to previous and has remained lower than most of the pre-2001 levels since. This pattern does not reflect applications, which showed spiking interest particularly in 2011-2012, 2014-15 and 2017, when applications reached over 800 per year for the first time since 1997.

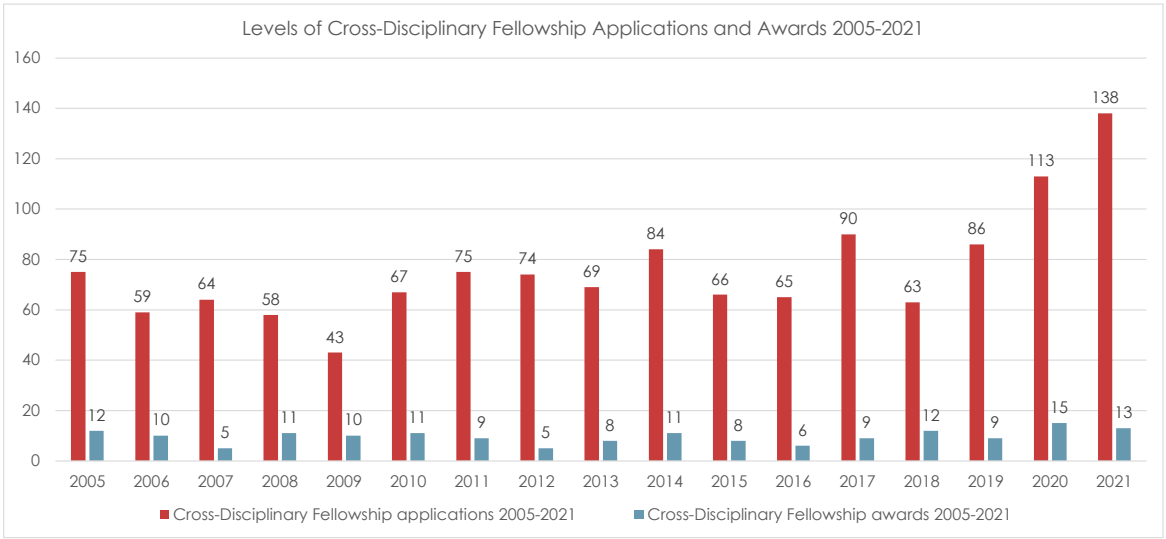
F.2.2. Long-Term Fellowships

Distribution of applications and awards for Long-Term Fellowships 1993-2021



F.2.3. Cross-Disciplinary Fellowships

Distribution of applications and awards for Cross-Disciplinary Fellowships 2005-2021



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