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ON YOUR MARKS, GET SET, FUND! RAPID RESPONSES TO THE COVID-19 PANDEMIC

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ABSTRACT

This paper presents findings from an analysis of seven multidisciplinary national research funders' responses to COVID-19. We posit that while some parts of research and innovation funding responses to COVID-19 were 'pandemic responses' in the conventional biomedical sense, other parts were thematically far broader and are better termed 'societal emergency' funding. This type of funding activity was unprecedented for many funders. Yet, it may signal a new/additional mission for research funders, which may be required to tackle future societal emergencies, medical or otherwise. Urgency (i.e., the need to deploy funding quickly) is a key distinguishing theme in these funding activities. This paper explores the different techniques that funders used to substantially speed up their application and assessment processes to ensure research on COVID-19 could commence as quickly as possible. Funders used a range of approaches, both before application submission (call design, application lengths and formats) and after (review and decision-making processes). Our research highlights a series of trade-offs, at the heart of which are concerns around simultaneously ensuring the required speed as well as the quality of funding-decisions. We extract some recommendations for what a generic 'societal emergency' funding toolkit might include to optimally manage these tensions in case national research funders are called upon again to respond to future crises.

INTRODUCTION

This paper presents findings from an analysis of seven multidisciplinary national research funders' responses to COVID-19. The background work for this study was conducted as part of a recently completed process review of UKRI's research and innovation (R&I) response to COVID-19 (Kolarz et al, 2021), which included a substantial international comparative dimension.

We begin by positing that funders' responses went decisively beyond pandemic response in the conventional sense and amounted to a largely unprecedented type of R&I funding. COVID-19 marked the first time many research funders were called on to rapidly mobilise researchers from a broad range of disciplines and fund large bodies of research as rapidly as possible to respond to a major unfolding societal crisis. And it may not be the last.

OECD figures help to give a sense of the scale of the global R&I funding response to COVID-19: the OECD Science, Technology, and Innovation Policy Compass COVID-19 tracker database lists 702 policy initiatives targeting COVID-19 pandemic across the OECD countries (OECD, 2021b). The OECD estimates that over $7b were unlocked in the first nine months of 2020 (OECD, 2021a). Funders introduced new measures and extended the duration of ongoing research and deadlines for new calls for applications (Stoye, 2020). In some cases, funders made only one-off investments in 2020, whereas other measures continue to operate in 2021.

Across many of these measures, the need for a rapid response meant that 'business-as-usual' funding processes had to change – at least by accelerating existing processes, or indeed by modifying them more substantively. At the same time, funders had to ensure that acceleration and modification did not compromise the quality of decision-making, i.e., that they still funded high-quality research.

Studying and understanding these funding responses has merit from an evaluative point of view: did funders perform as well as they could have done? But COVID-19, its countermeasures and consequences also highlighted the critical role that public research funders play in major societal emergencies. Understood as a wider societal emergency rather than strictly as a pandemic, an assessment of funders' responses to COVID-19 can therefore also help to define some parameters for a rapid-response toolkit suited to future crises, health-related or otherwise.

Academic literature on the need for rapid research and the response of funders is scarce. It focuses either on the implications for research practice (see, for example, Richardson et al, 2021; Lurie et al, 2021) or on funding for clinical research. For example, the main recommendation of Sigfrid et al.'s 2020 review of the academic literature on clinical research responses to pandemics (including COVID-19) was to increase STI preparedness before a pandemic rather than a purely reactive response. Dedicated emergency funding for the rapid release of funds, strong international collaborations and community engagement (e.g., involving affected communities in programme design) from the outset were cited as key enablers for a successful rapid STI response.

In its most recent STI Outlook, the OECD has roughly outlined some of the approaches taken by funders and highlighted some of the challenges (OECD, 2021b). However, we are not aware of published work exploring this topic in detail with primary data from funders or looking across multidisciplinary research responses.

APPROACH

We used an exploratory comparative case study approach for this study to allow for an iterative analysis of each case (funder) with a final comparison of emergent themes and explanations (Mills et al. 2010). This approach is particularly useful for analysing organisational processes and change in response to a common external problem (i.e., the research needs to understand and address the impact of COVID-19).

The study covers seven research funders: the Dutch Research Council NWO and its sister organisation for health research ZonMw, the German Research Council DFG, the UK national funding agency UKRI, National Research Council of Canada (NRC), the Japan Science and Technology Agency (JST), the Ministry of Science and Technology of Taiwan (MoST) and the National Science Foundation (NSF) in the USA.

The study used desk research and interviews. The information available on the funders' websites, meeting protocols, reports and grey literature were used to conduct the desk research. Semi-structured interviews with representatives of funders[1] were conducted to fact-check the findings of desk research and gain insights into challenges the funders faced in introducing and implementing their responses to COVID-19. Interviews were conducted with personnel directly involved in the design and delivery of the response and had strategic oversight of their funder's mission and role in the respective R&I system.

A common template was used across cases for structured data collection. The analysis was performed from April to July 2021, when most funders had completed the first rounds of response mechanisms and were ready to reflect on the first lessons learned.

This study has some limitations. First, it is based on funders' perceptions, which can be biased, though we worked to substantiate their accounts with documentary evidence where possible. Second, it covers a limited selection of funders (from developed countries) and cannot be globally representative but does provide a view of some of the most active funders in the world on this issue. Third, the success of funders' response might arguably be better judged in the longer-term post-pandemic. However, the focus of this study is around short-term response processes and learning from them for future crises. This means that funders' ability to deploy funding rapidly is a key success criterion: unlike in other funding activities, where it is usually accepted that impacts may only appear 'downstream', often after many years, large parts of funders' responses to COVID-19 were intended to produce impact and actionable knowledge within months. Finally, the study covers only rapid funding instruments and does not explore the effects of the pandemic or rapid response on other funding priorities and instruments. Although such a wholistic understanding would be very relevant, it merits a separate investigation and is an area for further research.

FROM 'PANDEMIC RESPONSE' TO 'SOCIETAL EMERGENCY'

The mission of each funder was not always discernible or fully predefined, but urgency is a core theme that characterises all funders' responses. Accordingly, all funders introduced programmes aiming to quickly support research to understand and address the impacts of COVID-19. Table 1 provides a brief overview of the reviewed funders' responses to the COVID-19 pandemic.

Table 1 Reviewed funders' response to COVID-19

Funder	Response to COVID-19	Overall funding and number of supported awards
NWO and ZonMw, Netherlands	Corona: fast-track data call for applications (NWO) Two waves of the research programme COVID-19 (NWO and ZonMw) 'Virus Outbreak Data Access Network' initiative for data sharing	COVID-19 programme provided €56.5m to 235 awards. Fast-track data programme provided €1.5m to 34 awards.
DFG, Germany	Set up of Interdisciplinary Commission for Pandemic Research to steer the response to COVID-19 Call for Multidisciplinary Research into Epidemics and Pandemics in response to the Outbreak of SARS-CoV-2 COVID-19 Focus Funding instrument	COVID-19 Focus Funding provided €3.6m to 33 awards (first call). Call for multidisciplinary research into epidemics and pandemics provided €30m to 50 awards.
UKRI, United Kingdom	Fifteen COVID-19 research programmes and interventions, including: joint agency programmes (e.g., UKRI-NIHR programme funded the Oxford/AZ Vaccine), international programmes (e.g., GECO - Global Effort on COVID-19 Health Research), UKRI COVID-19 Agile R&I response call, infrastructure (Vaccine Manufacturing Innovation Centre [VMIC]), and policy programmes (National Core Studies)	UKRI provided £647.2m to 1,057 awards from February 2020 to May 2021. Significant investments were the VMIC (£200.2m) and the UKRI Agile Open call (£172.5m)
National Research Council Canada (NRC)	The Pandemic Response Challenge programme and new Vice president to lead the programme New infrastructure projects (manufacturing, clinical trial centres) Industrial Research Assistance Programme challenges for businesses	Pandemic Response Challenge programme provided €15m to 6 awards in 2020.

1 Except NSF, who could not be reached for consultation.

Funder	Response to COVID-19	Overall funding and number of supported awards
Ministry of Science and Technology of Taiwan (MoST)	MoST introduced new accelerated funding instrument with supplementary funding to support: Short-term missions focusing on quick solutions for testing, treatment, vaccines Long-term missions focusing on epidemiology and policy making	C-19 research call provided €30m.
Japan Science and Technology Agency (JST)	Covid call in the Strategic Basic Research Programme J-RAPID programme funding international collaborative research	J-RAPID provided €4.1m to 11 awards. CREST provided €30m to 10 awards in 2020.
National Science foundation (NSF), USA	NSF responded to COVID-19 by investing $75m in fast response research through its RAPID mechanism previously deployed to respond to other emergencies.	RAPID provided $75m to over 1000 awards up to end of October 2020.

Among the earliest and most evident observations in our research was that there is an important core distinction within the R&I responses to COVID-19, namely between what we term 'pandemic response' conventionally defined, and a much broader element we term 'societal emergency' funding. The remainder of this paper focusses on the latter, so we describe the distinction here.

While the scale of the COVID-19 pandemic was unprecedented, little is new about research funders conducting or aiding a pandemic response. Research funders in the biomedical sciences have coordinated efforts and provided rapid funding before, responding to other health emergencies such as Zika and Ebola outbreaks (Oliveira et al, 2020). Besides such past experiences, research funders conducting a pandemic response to COVID-19 could also rely on guidance and standard processes from Glopid-R and the WHO R&D Blueprint.

Many of the funders covered in this study made substantial contributions towards tackling the pandemic itself. This focused on therapeutics, diagnostics, and understanding the spread of the disease, typically in a biological/genetic sense, though occasionally also involving social scientific work. Often, these pandemic response activities were centred on a small number of known competence centres within a few specific fields.

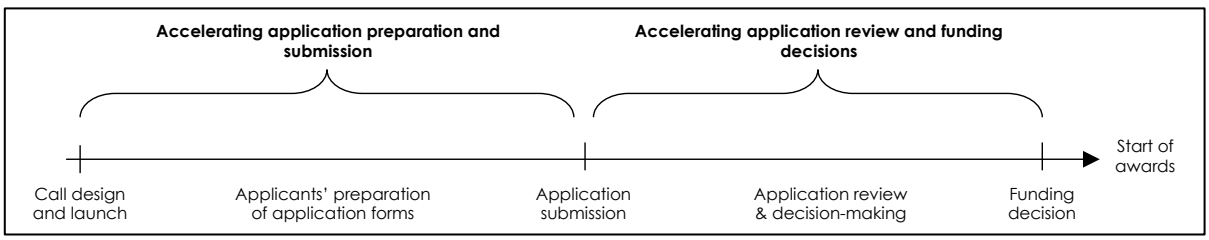
Beyond the early months of 2020, the R&I funding responses expanded beyond what is typically understood as 'pandemic response' into broader medical, biological and public health questions, as well as to technological and socio-economic implications. Far greater and more diverse sections of national research communities needed to be mobilised. There were fewer instances of 'obvious' candidates to carry out research, and the topics of interest (e.g., air quality, socio-economic effects of lockdown and school closures) required far more agile and wide-reaching approaches to keep pace with increasing and evolving research needs and priorities. Implicitly, these funding activities understand COVID-19 not only as a pandemic affecting public health, but as a much broader and multi-faceted societal emergency.

The emphasis between these two elements of COVID-19 response funding differs among the funders we covered. None of the funders we studied are the sole research funders operating in their respective country, and this has some impact on the shape of their response. For example, in the US, Canada and Germany, other health research funders made substantial investments in response to COVID-19 while the funders we covered focused on other disciplines. The 'pandemic response' element was typically covered by specific health and biomedical research funders, or by equivalent thematic divisions within multidisciplinary funders. The wider 'societal emergency' aspect was typically relevant across the entire disciplinary remit of multidisciplinary national research funders.

As such, all comparator funders supported social science research in addition to biomedical, natural science and engineering research. Some funders only introduced new rapid support measures (e.g., NWO, ZonMw, DFG), whereas other funders (e.g., NRC) were also tasked to deliver new research infrastructure. Some (e.g., UKRI, JST, NRC) introduced or took part in international collaborative programmes, once again in many different thematic and disciplinary domains related to COVID-19 and its wider societal implications.

In this paper, we focus on the wider 'societal emergency' response of multidisciplinary national research funders rather than on the 'pandemic response' of specifically medical research funders or funding divisions.

Figure 1 How funders facilitated rapid funding response processes



Our rationale for this choice is while the latter was by no means an easy or less important task, it was able to draw on prior experience and existing guidance and was limited to a small number of fields and actors suited to carry out the required research activities. The former, by contrast, had little precedent or 'blueprint' and a much broader thematic remit. The lack of precedent, combined with the possibility of future societal emergencies, also means that these 'societal emergency' funding activities beyond 'pandemic response' are particularly likely to include valuable lessons for the future.

In the following sections, we show how funders facilitated rapid funding responses. We distinguish between the processes and activities before and after the point of application submission (Figure 1), as the acceleration mechanisms – and the resulting challenges – are distinct during these two stages: the former pertains to application format and ensuring inclusive participation; the latter pertains to review processes and, most notably, to whether and how peer review can be adapted to the context of a societal emergency and consequent rapid funding deployment.

RAPIDLY RESPONDING TO SOCIETAL EMERGENCY: APPROACHES AND CHALLENGES

DESIGNING AND LAUNCHING THE RAPID RESPONSE PROGRAMMES

All the funders reviewed showed flexibility in their ability to respond to the pandemic quickly. However, we note for context that some funders could draw on prior experience in responding to societal emergencies, meaning they had existing schemes or structures for such purposes. While these may have needed some modification in some cases, other funders needed to create their funding tools from scratch or substantially alter existing schemes that had not been designed for emergency response.

MoST and JST had previous experience responding to natural disasters, pandemics or other crises. ZonMw had experience responding to previous epidemics. Taiwan had already invested significantly in pandemic preparedness after the SARS outbreak. Japan had previously needed to react to major earthquakes and other disasters, so JST used its J-RAPID programme for the emergency response. This, in turn, had been influenced by the NSF's RAPID programme, which had been used in previous emergencies such as Hurricane Katrina. Thus, NSF and JST deployed existing emergency tools, only needing to adjust the programmes for the new emergency at hand.

NRC organised their pandemic response in the framework of the Challenges Programme, creating a specific Pandemic Response Challenge Programme. NRC used the already existing programme mechanisms and did not significantly alter the processes because they believed that using an existing framework would allow them to respond faster than creating a new one.

NRC, MoST and JST also reported fewer problems with implementing the measures, both in terms of organising application preparation and review. This is partly because they used previously tested mechanisms and, as noted above, MoST and JST had overall higher emergency preparedness.

Other funders – NWO and ZonMw, DFG, UKRI – designed new measures or significantly altered existing ones. They reported spending some time on new call design and launch, which often involved some form of formal approval implying lengthier processes, particularly when more than one funder was concerned. For example, NWO and ZonMw started a new joint programme and coordinating between the two funders took slightly more time.

However, funders without ready-made rapid-response instruments reported that management prioritised rapid response over any other activities and accelerated approval processes. Thus, even when funders did not have emergency instruments and had to create new ones, they spent less time approving new measures and starting the operation than would normally be the case for new funding tools.

However, quickly introducing rapid-response measures came at the cost of funders' staff increased workload. Planning and launching calls quickly put significant pressure on the funders' staff. Funders reported significantly increased workload, working overtime and on weekends in remote work circumstances to launch the rapid funding instruments. All consulted funders pointed out this can only happen for a short period and cannot become the norm. Only in countries less affected by the pandemic and with previous experience with responding to a societal emergency (e.g., Taiwan, Japan) did research funders manage to organise the COVID-19 response with less pressure on staff at the design and launch stage.

ACCELERATING APPLICATION PREPARATION AND SUBMISSION

All comparator funders shortened award application timelines, and most of them reduced the length of application forms. The extent to which the time for application preparation was reduced varies among the funders. For example, Dutch health research funder ZonMw reduced the time for application preparation for its interdisciplinary COVID-19 programme from the usual 2-3 months to two weeks. DFG, NRC, MoST and JST allowed longer time periods for application preparation (around one month), but these were still substantially shorter than business-as-usual in all cases.

NWO's Fast-track data programme stands out for its exceptional level of acceleration at this stage: aiming to support data collection for urgent pandemic related research, the programme had a "first-come, first-serve" principle, meaning for example that NWO published the call for applications on a Friday, and by Tuesday the following week, NWO had received enough applications to be able to allocate all budget. NWO programme managers reviewed the applications as soon as they came in. The funder approved applications meeting the minimum requirements of relevance, urgency, expertise, and feasibility.

Two main approaches were evident in terms of reduced application length, which different funders used to varying extents: on one hand, there is the possibility of keeping application form structures the same (i.e. have all the 'usual' sections) but reduce the permitted word or page limits. Most funders followed this approach. On the other hand, there is the possibility of removing some of the business-as-usual application sections altogether. We learned that two funders in our review chose to do this.

DFG and NSF reduced the application length significantly, limiting the usually lengthier applications to just five pages. Other funders opted for a similar but less pronounced approach, reducing the usual length of applications forms only slightly. By contrast, NRC did not make changes of this type, using instead its Challenge Programmes framework to organise its response. Although the programme was new and focused on the pandemic, it used existing Challenge Programme procedures, including application forms. Though not an emergency funding tool as such, NRC deemed the application process and forms for this programme suitable for the urgency of the pandemic. This meant that NRC did not have to create new application forms and reported that this allowed them to launch the call quickly and save time on re-designing or developing new application forms.

Most funders reduced the total length of the applications, not removing specific sections. However, this was not the case for significantly reduced applications. For example, DFG asked for a maximum of five-page applications for its COVID-19 Focus Funding instrument and did not ask applicants to provide information on their track record due. Similarly, in the NSF's RAPID programme form, the key information was largely centred on the proposed research subject.

The rationale for shortening application timelines is self-evident in the circumstances. Likewise, reducing the length and/or detail of applications (both by word/page limits and by removing some of the 'standard' sections altogether) is in part a corollary of this: with shorter time available to applicants, shorter applications ought to help applicants put together an application under such tight constraints. In addition, reviewers have less material to review, which may in theory mean less time spent on reading and assessing applications.

Whilst these steps were almost certainly necessary, our research finds several challenges with shortened applications, both in terms of timelines and application lengths.

One challenge associated with short application deadlines is the quality of the applications and later award implementation. For example, ZonMw observed that some rapidly selected awards later required changes in the project plan because of unanticipated problems during the short application development. DFG reported the quality of applications received for COVID-19 calls was poorer than usual and speculated it might have been due to shorter application preparation time. This was also the case for UKRI's open calls, which attracted a substantial amount of out-of-scope and/or poor-quality applications (alongside many good ones) compared to business-as-usual.

Two funders (DFG and UKRI) experienced challenges with ensuring that peer-review panels had sufficient information to assess applications. As a result, DFG reported that peers sought alternative information resources to find the information that was missing in the applications. Peers needed more time to complete the assessment, and the quality of the additional information peers used could not be assured because it was not provided systematically for all applicants. UKRI staff also commented on the need to regularly source more information from applicants for peer reviewers due to the short application forms used in their Open Call.

The rapid organisation of funding calls also raises concerns about unequal opportunities for some research community members and sustained research career opportunities. NWO reported that fast submission requirements raised concerns in the research community because researchers with care responsibilities could not respond as quickly as others, leaving them at a disadvantage. Elsewhere, it has been reported that female researchers published fewer preprints during the pandemic and started fewer new research projects than males (Viglione, 2020).

In summary, accelerated submission timelines are critical to ensure rapid funding responses and shortening application forms can be a helpful component in this, including for applicants, funder staff and reviewers. However, our research shows that shorter preparation time coupled with lowered barriers to entry may lead to large volumes of applications and lower overall quality of the application pool. This in turn also creates a high burden for the funder's staff and peer-reviewers. Finally, challenges arise to ensure equal inclusion of researchers with difficulties responding quickly.

ACCELERATING APPLICATION REVIEW AND FUNDING DECISIONS

We now turn from the pre-submission to the post-submission phase of COVID-19 response funding. However, we note that several of the features highlighted above also have an effect here on the length or brevity of applications, as well as the large volumes of applications submitted to calls.

Most comparator funders relied on peer-review to assess the applications submitted for COVID-19 response schemes. The main reason for peer-review was (as with regular funding) to ensure scientific quality. At the same time, funders applied new mechanisms and alterations to their usual processes to accelerate peer review. However, several funders also either partly or completely[2] bypassed peer-review in their rapid response.

Funders that least deviated from the traditional peer-review simply instructed peer-reviewers to conduct their reviews in the usual format, but to do so quicker than usual, as JST did in its CREST programme COVID-19 call. This was not the first time JST responded to an emergency in this way, and they already knew they would be able to mobilise the peer community. ZonMw also reduced the peer-review length from 2-3 weeks to receive peer feedback in a few days by simply requesting a fast response from reviewers. Requests for a fast response appear to have been largely effective.

Other funders made more targeted changes in the peer-review process by reorganising and shortening the review process. DFG abolished written panel reviews in the COVID-19 Focus Funding instrument, instead asking peer reviewers to present assessments already written in the panel meeting. DFG also integrated the work of a Review Board with the Grants Commission, usually held separately, saving more time. JST cancelled the joint evaluation meetings between the funders involved in its international J-RAPID programme and instead relied on the assessment provided by partner funders.

We found very few examples of funders making use of two-stage applications (e.g., pre-application followed by a main application). We did not expect this approach to feature strongly in COVID-19 responses due

2 In cases where processes fully by-passed peer review, funders' staff still had an option to involve peer-review to inform their decisions if necessary.

to the extra step taking additional time, despite its common use especially in thematic funding more generally. However, Taiwan's MoST used such an approach, filtering pre-applications to select fewer and better-quality applications that went to full peer review. MoST also organised more panel meetings to speed up decisions.

Finally, three funders by-passed peer-review almost entirely in some of their rapid-response mechanisms. NRC used peer-review for parts of its Pandemic Challenge Programme, but also relied heavily on internal knowledge to assess the applications when needed to speed up the process and support high-risk appetite in its pandemic response programme. This was largely possible because NRC also operates 14 research centres employing scientists and can therefore quickly mobilise relevant scientific expertise.

NSF also relied on its own internal expertise. NSF's RAPID grant mechanism is the only NSF funding mechanism where the funder generally bypasses peer review. It relies on NSF officers for application review and approval. The officers can organise external review if they feel it necessary, but that is not the standard practice. It is designed for quick responses to emergencies, such as when NSF used it in response to hurricane Katrina.

Finally, NWO also made decisions on applications without peer review in its Fast-track data programme. This programme provided small grants and aimed to support rapid data collection during the crisis. NWO therefore decided that its staff should quickly conduct assessments of applications.

The examples of funding instruments that fully or partly bypass peer review are for awards of relatively small sizes. For example, the NWO programme provided maximum grants in the value up to €50k, NRC's programme up to CAN$100k, and NSF RAPID grants were up to US$200k. All programmes asked for short applications. In these examples, funders placed trust in the expertise of their staff (including research centre staff in the case of NRC) and could rely on peer-review as a backup if they encountered difficulties in making the assessment.

As evident from the above examples, research funders used various means to adjust the peer-review process to the urgency of societal emergency. The observed approaches effectively form a 'scale', ranging from making no process modifications and simply speeding up existing processes, via introducing minor administrative efficiencies, simplifying processes (e.g., through the introduction of standing panels), to bypassing peer review almost entirely.

Depending on which approaches they took, funders experienced a range of different and partially interlocking challenges. In varying combinations and trade-offs, these challenges revolved around funder staff and reviewers' workload, the volume of applications received and, critically, the ability to fulfil the requirement of urgency.

Some funders reported that it took too much time to channel funding to awards that had to deliver results very soon. This applies to funding instruments that relied on peer review (or peer review with minor efficiency savings) and saw a high volume of applications – in part as a corollary of shortened application forms and reduced barriers to entry, but also due to the broad thematic remit of calls. For example, DFG cut some steps in the peer-review process and did shorten timelines compared with business-as-usual but was still not satisfied with the length of time the whole process required. UKRI likewise retained peer review (with some efficiency savings in parts of its response) but did not fulfil its ambition of reaching funding decisions within 2-6 weeks on all applications. Such delays were not entirely a result of peer review itself, but also of the need to quickly process a large volume of applications in this way.

Such time delays are not evident in instruments that simply asked reviewers to return their feedback much faster. The three funders who relied on this approach (JST, MoST, ZonMw) did not report any significant problems or failure to meet the objectives related to urgency. However, even at smaller scale, this approach was deemed unlikely to be sustainable as it implies a heavy workload for peers and was noted not to be feasible for very large funding instruments with many applications.

Funders that bypassed peer-review did not report any problems with not meeting the urgency objectives and believed[3] they made funding decisions faster without, rather than with, full peer-review. However, as noted, bypassing peer review was only practiced for small-sized awards.

Related to the above is the issue of funders' staff workload associated with managing large numbers of applications and accelerated peer-review processes involving recruiting peers and repeated requests to peer-reviewers to return their assessments. The same also applies to funders who rely on their staff for application assessment mainly because rapid response mechanisms received many applications. To address this, NSF requested the applicants to contact NSF officers before submission to ascertain if their application would be appropriate. Still, even with this procedure, NSF received thousands of applications.

In short, funders faced the most serious challenges when trying to accommodate large application volumes (brought about by broad topic remit and shortened applications), conduct more-or-less full peer review on most or all applications, and ensure rapid funding deployment (as demanded by the situation). Generally, it was the latter issue on which funders fell short in such cases. However, substantial workload and stress levels for reviewers and/or funder staff also occurred in instruments where at least one of these three parameters (volume, speed, peer review) was removed.

URGENCY VERSUS QUALITY? UNPACKING THE DICHOTOMY

Research funders accelerated funding mechanisms throughout the whole funding process. Table 2 presents an overview of the accelerated funding mechanisms we identified - from shortened pre-application timelines to expedited peer-review and summarises the associated advantages and potential hazards.

3 Note that evidence on the NSF RAPID instrument is based only on desk review.

Table 2 Funding mechanisms at a glance – advantages and disadvantages

Mechanism	Main Advantages	Main Hazards
Shorten timeline from call launch to submission	Shortening of the overall funding process	May result in poorer quality proposals May exclude individuals with caring responsibilities or otherwise unable to respond
Shorten application form (lower permitted lengths and/ or remove sections)	Eases applicants' ability to write applications in short times available May enable faster review	Lowers 'barriers to entry', potentially leading to large volumes of applications May lead to information gaps for reviewers
Expression of interest or pre-application phase prior to full application	Lowers the volume of applications going to peer review Increases relevance of the pool of applications	Takes additional time May mean substantial workload for funder staff or standing panels in charge of 'sifting'
Full peer review of standard-length applications	Optimally safeguards scientific quality and standards	May either take a long time or require substantial pressure on reviewers Not suitable for urgent funding in conditions of high application-influx
Simplified decision-making process (e.g., combining/by-passing some decision-making bodies)	Leads to minor time/efficiency savings May slightly reduce administrative burden	May not be suitable for large award sizes or funding decisions that require strategic oversight
Modified peer review (e.g., standing panels only, no individual remote peer reviews)	Leads to some time savings May reduce funder staff burden to identify remote reviewers	Substantial pressure on standing panels, especially in cases of high application influx
No peer review (or in exceptional circumstances only) – decision by funder staff	Substantial time savings No or minimal administrative burden to identify/ organise external peer or panel reviews	Potential lack of process-trust from the research community (or requires trust in funder staff) Generally only deemed feasible for small awards

Pre-submission process alterations allowed to save time but also caused some challenges. Key challenges were around proposal quality, information gaps for reviewers and large volumes of applications. Post-submission peer-review is where we saw most change, challenges and opportunities. Thus, we discuss this in more detail onwards.

Traditionally, peer review has been the default mechanism to make decisions in research grant funding. Specifically, a sequence of external peer reviews followed by ranking and sorting of applications by a review panel is in use at almost all research funders across the globe, be it for basic research funding, thematic funding, or innovation-oriented funding. The research community places a great deal of trust in peer review, and while the 'peer review burden' has been acknowledged for some time (Guthrie et al, 2013; Herbert et al, 2015; Schroter et al, 2010), the use of peer review to allocate funding does not present an operational difficulty.

This changed in the context of the 'societal emergency' funding activities conducted in response to COVID-19. The range of process decisions taken by the funders signal a perceived tension between the need for urgency on one hand and the need to conduct the fullest possible peer review on the other. If we understand peer review as a central mechanism for scientific quality assurance, we can simplify the central tension to 'speed versus quality'. This tension is exacerbated when dealing with large volumes of applications.

Several interviewees for our study acknowledged this perceived tension and indeed, the funders we reviewed responded to this tension in several different ways – in some cases, the same funder managed it differently in different funding instruments. Regardless of the approach taken, managing the tension between urgency and the need for peer review typically resulted in at least some personal cost in the form of stress and high workloads, either to funder staff or to reviewers, or to both.

This tension highlighted in funders' COVID-19 responses illuminate some long-lasting issues with research funding. One is the debate about the quality of peer-review. Scholars have pointed to the lengthy processes it involves (Guthrie et al, 2013), and there is growing evidence that peer reviewing all applications or relying exclusively on peer review does not necessarily lead to optimal funding outcomes. Peer review may lead at least in part to arbitrary outcomes especially in conditions of high application volumes and low success rates (Abdoul et al, 2012; Clarke et al, 2016; Graves et al, 2011; Mutz et al 2016). The urgency of 'societal emergency' funding thus provides grounds to question whether peer review should always feature.

The literature also shows that peer review may be biased against risk, i.e., putting especially innovative and 'transformative' ideas at a disadvantage (Guthrie et al, 2018; Langfeldt, 2006; Nuffield Council on Bioethics, 2014). For example, Franzoni et al (2021) discuss peer-review aversion and, in light of the pandemic, illustrate how Katalin Karikó, a scientist who conducted pioneering research related to mRNA-based drugs, did not succeed with her early applications for funding because their research was considered too preliminary and risky.

Problems with lengthy processes and risk aversion became evident also in some aspects of the pandemic response. It raises the question of whether traditional full peer review is always compatible with rapid response. Complete or partial bypassing of peer-review might also be rel-

evant to open the doors for risky and potentially breakthrough research if that is the desire of the funder. 'Pandemic responses' in the conventional sense (see above) may not be the right place to contemplate high-risk funding. But 'societal emergencies' more generally might in part require riskier solutions to complex and novel problems.

Looking across the experiences of funders covered by our study, the speed and quality assurance are not a straightforward dichotomy, or even part of a one-dimensional 'scale'. The range of processes and modifications used across the seven funders highlight that there is a range of levers that may be combined in many ways. These offer a starting point to constructing generic emergency response toolkits that may be drawn upon in the future.

CONCLUSION: TOWARDS A RAPID-RESPONSE TOOLKIT FOR NATIONAL RESEARCH FUNDERS

Research funders are typically understood to have up to three 'missions': first, to fund basic, curiosity-driven research, bottom-up (researcher driven) and in the shape of projects and fellowships. Second, to fund innovation related activities (this especially applies to combined R&I funding agencies). More recently, research funders have also taken on thematic missions, aiming to fund research relevant to solving societal challenges, for example in relation to the UN Sustainable Development Goals and through 'research for development' programmes. We note that these missions are sedimentary: the presence of new missions does not make older ones less important but rather expands the range of funders' activities. The importance of funding basic research without top-down thematic imperatives is well established (see e.g., Kohse-Höinghaus et al., 2019) and we concur with such sentiments.

'Societal emergency' funding may present a fourth 'mission' for funders: though essentially oriented to solving a societal challenge, it is distinct from thematic funding due the extreme urgency characterising its deployment.

Large amounts of funding reached researchers faster than usual owing to process modifications. Some have raised questions whether the introduced changes can be transferred into the everyday operation of funders (OECD, 2021b; Wilsdon, 2021). Given the challenges experienced by funders, we likewise find it unlikely that many of the approaches taken for COVID-19 response funding are appropriate for 'business-as-usual'. For this reason, we deem it most appropriate to understand 'societal emergency' funding as a distinct activity requiring distinct processes.

Funders across the globe mobilised to respond to the societal crisis brought about by COVID-19. For many of them, this was the first time they needed to deploy funding rapidly in this way. Our assessment highlights that rapid funding requires adaptations to the usual funding process to ensure that research can produce impact within helpful timeframes.

In cases of societal emergency, our findings highlight a (non-exhaustive) selection of levers and techniques available to funders. Some of them rule each other out, others do not. Not all are useful for all types of awards, so if we contemplate a toolkit or guidance for 'societal emergency' funding, we need to consider:

- The size (monetary value) of awards
- The level of urgency (these might differ depending on the nature of the crisis or which aspect of the crisis is sought to be addressed by the funding)
- The thematic breadth of the call (likely a determinant of the volume of applications)
- The level of 'risk-appetite' (e.g., based on the need for especially innovative solutions in what may be uncharted territory)

Societal emergencies may require several different types of awards, suggesting that funders need to have a range of funding tools at their disposal and systematically use the 'levers' of topic urgency, risk appetite, award size and, ultimately, internal knowledge and expertise to make rapid decisions where feasible.

The experiences of NSF and JST illustrate the value in having a purpose-made rapid response funding instrument ready for use for societal emergencies. The NSF RAPID and JST J-RAPID programmes allowed both funders to use the institutional knowledge and previously tested processes to mobilise for the COVID-19 pandemic. However, the tensions and choices described in this paper suggest that a ready-made suite of funding tools for societal emergencies might be even more useful. While we do not wish to be prescriptive (full lessons from COVID-19 funding responses across the globe have yet to be drawn), our findings allow us to posit as a generic model of three scheme types – to be deployed with varying emphases depending on the nature of a societal emergency and its consequent research-needs:

1. **An instrument to fund awards as rapidly as possible, using minimal or no peer review:** this may be reserved only for the most urgent research-needs that need to be deployed within days rather than weeks (e.g., rapid data collection needs to monitor a particular aspect of an unfolding crisis). Thematic remit ought to be relative tightly defined and informal enquiries or expressions of interest possible, to limit the influx of out-of-scope applications. Internal funder staff to review and take funding decisions, with additional experts to be consulted informally if required. Other than in exceptional circumstances, awards on this scheme would be of relatively low financial value. This instrument may ideally have one or more topic-specific and highly time-bound calls rather than being a rolling open call throughout the crisis. Because of urgency, short applications, and a shorter than usual timeline for submission, would be reasonable

2. **An instrument to fund awards rapidly using simplified or modified peer review:** societal emergencies might have a broad and multi-disciplinary range of research-needs that are urgent but can countenance a few weeks of waiting-time. This scheme should be designed to accommodate a high intake of applications but process them relatively quickly. This could be facilitated through a 'sifting' stage where 1–2-page pre-applications (or summary sections of full applications) are rapidly sifted for relevance by funder staff or by a standing panel, so that the volume of applications going to full peer review is limited. Full applications and application timelines may be shorter than they would be for equivalent-sized business-as-usual awards. Funders may consider using standing panels to conduct reviews, relying on

additional expert reviews only in cases where panels do not have sufficient thematic knowledge to make judgements. This instrument may have one or more topic-specific and time-bound calls, or may take the shape of a rolling open call with a loosely delineated (and potentially evolving) topical remit

3. **An instrument to fund large, strategic awards relatively rapidly using full peer review:** where research needs are pressing but not immediate, larger awards (e.g., for centres, facilities, and major consortia) may require full external peer and panel review. For such instances, this instrument will most closely resemble a funder's business-as-usual processes, including full-length applications, both to ensure high standards of scientific quality assurance and to heighten barriers to entry (i.e., reduce application influx). Pre-applications or applications by invitation only may be considered for this instrument. Peer reviewers may be briefed that reviews in this scheme constitute exceptional circumstances, meaning that peer reviews need to be returned within a much shorter time than usual. Public agencies other than the research funder may also provide input into decisions on strategic investments (e.g., as was done by the Scientific Advisory Group for Emergencies [SAGE] for UKRI's response)

As with any other funding measure, rapid-response mechanisms should remove barriers preventing all researchers from contributing. It can be challenging to balance the urgency and need for quick submission of applications. Still, funders can introduce flexible policies to accommodate the needs of the research community, train staff or peers involved in assessing the applications to assess applicants equitably or provide support to cover care costs.

We stress that the above is an initial suggestion and primarily intended as an illustration of the combination of best practices revealed in our research. Experiences of the many funders not covered by our study may yield additional insights leading to substantially different models. Further, as impact evaluations of various funders' COVID-19 responses take place and reach the public domain, additional insight will be gained into what kinds of funding instruments and process modifications produced the most relevant, consistent and/or innovative results.

'Societal emergency' funding may become a new occasional mission for research funders. The funders who participated in our study must be lauded for their efforts and thanked for their participation. Whether COVID-19 was their first societal emergency response or not, our research found ample markers of good practice, and we offer our findings as a first step towards easing the burden of any future crises that may come.

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