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FUTURE CHALLENGES

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Effective or predatory funding? Evaluating the hidden costs of grant applications

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Investment in research is expensive, but can lead to very strong returns in the medium and long term.[1] An increasing fraction of research funding is distributed by competitive grant calls rather than through the general base funding of universities and research institutions. The overarching rationale behind competitive funding schemes is to allocate finite resources in a way that enables the most innovative and productive research directions. However, despite extensive efforts invested in applications and evaluations, the current funding system shows striking deficiencies in reliably ranking the relative research quality of proposals.[2–4] Besides problems to meaningfully differentiate between too many high-quality proposals, the review process appears to conflate the curriculum vitae of the applicant with the research proposal itself.[5] Although there is in principle nothing wrong with taking previous success as an indicator for future success, these observations challenge the need for the most time-consuming, and thus costly, part of the funding application: the composition of the grant proposal itself. In addition, the current practice leads to a considerable concentration of funding resources on few research groups (known as the "Matthew effect") that is to a considerable degree independent of eventual research impact.[6,7]

These observations, in line with general findings on the role of randomness rather than merit for success and failure in society,[8] suggest that the current funding system is not always a fair and meritocratic procedure, but to a noteworthy degree a disguised and considerably biased lottery—and a strikingly inefficient one.[9–11]

More generally, these observations raise an often-neglected question for all funding schemes: do their benefits outweigh their costs, on both the individual and societal level? At first glance, any initiative that provides research funding seems beneficial to research and society. However, writing grant proposals reduces the time available for research, which, at least in case of most academic researchers, is what society is paying them for. In recent years, charities are increasingly discussing how resources can be transformed as efficiently as possible into desired outcomes.[12] In contrast to this ideal, we have recently suggested that many funding schemes are inefficient to a degree that they may actually harm rather than support research.[13] Here, we further elaborate on this statement and discuss the most important points in more depth.

EFFECTIVE VERSUS PREDATORY FUNDING

To assess the total costs and benefits of any given grant call, the success rates and the time investment on the side of the applicants have to be included in the calculation, in addition to the administrative costs and those of the review/selection panels. Let us consider several real-world examples:

(A) The ERC (European Research Council) Advanced Grant had a success rate of 7.8% in 2020 [https://erc.europa.eu/news/erc-2020-advanced-grants-results], with an average grant size of

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€2.43 million. Hence, the mean expected return of investment per applicant is €194 000. Adopting illustrative annual gross salary costs of €90 000, the expected funding amounts to roughly 3500–4000 work hours for a senior researcher. Personal estimates suggest that applicants typically invest at least 300–500 h of time into a proposal (e.g. see Herbert *et al.* 2013[14] for similar estimates for other grant schemes). Therefore, even for such a large grant, the cost of proposal writing exceeds 10% of the total funding—in addition to the costs for the evaluation and administration related to the funding distribution. For considerably smaller grants such as the ERC Starting Grant (about €1.5 million, approximately 10% success rate) or, in particular, the Marie Skłodowska-Curie Postdoctoral Fellowship (about €200 000, approximately 15% success rate), the application investments will add up to a considerably larger fraction of the total expected value of the grant.

(B) Two private foundations in different European countries publish calls for grants of €50 000 and €120 000, with success rates below 5% and 2%, respectively. With these numbers, sometimes celebrated as an expression of the strong interest of the research community in the call topic, the expected value of a given grant proposal is in the range of €2500—which would fund the total cost of the applicant's research position for little more than a week. The application formalities differ: one requires an extensive project proposal adding up to 30 pages, whereas the other asks for shorter but highly specific answers to several questions, thus requiring time-consuming fine-polishing given the competitiveness of the call.

(C) A company publishes a call for research grants with a total funding pool of less than €200 000 for which more than 200 teams of researchers apply, with a success rate below 3%. The expected value of this grant scheme comes down to about €200 per single team member. The application format spans just 2 pages; however, it involves multiple specific subsections, thus requiring a dedicated composition and fine-tuning of the proposal text.

While the situation for the different ERC grants is unsatisfactory to different degrees given that the mere distribution process produces costs for the scientific community (mostly on the applicants' side) ranging from about 10% in the case of advanced grants to nearly 30% in the case of Marie Skłodowska-Curie Actions postdoc fellowships, the situation for Cases B and C is considerably worse: if the average work of all people involved per application within these schemes, including meetings, drafting, formatting, revising and budgeting, adds up to considerably more than a week (Case B) or even just a day (Case C), the grant draws more resources from the scientific community than it adds—with the additional costs of review and administration not even considered. Contrary to their official goal of supporting research, these funding schemes actually impede research as a whole, even while supporting a few single actors. To put it somewhat polemically: piling up the cash and burning it in the backyard would have been more beneficial to the targeted research communities than distributing it via the described grant calls. We could call such cases—where the expected value for the scientific community is negative—*predatory funding*. That is, despite good intentions of the respective funding initiatives, they are detrimental to research and society, as they prevent more research than they enable.

One might consider the term "predatory" inappropriate given that it usually implies ill-intent to exploit. While there might be single funding calls that primarily serve merely as PR for the donor, we fully agree that compared with common definitions of "predatory" in the realm of publishing,[15] most funding organizations do not prioritize self-interest at the expense of scholarship, push false or misleading information, or use aggressive and indiscriminate solicitation practices. On the contrary, we are convinced that the vast majority of funders have a sincere interest in supporting science, and would be happy to reform any practices that might turn out to be detrimental to this aim. However, just as the actions of predators in the animal kingdom (including some of humankind's most beloved pets) are not an expression of ill-intent, but simply an evolved habit, some of the funding practices that have evolved over time do have unintended effects with a considerable negative impact on the scientific ecosystem. Motivational and epistemic causes for non-effective donations are multifold,[16] and it is all too understandable that not all funders are aware of potential inefficiencies or even harmful implications of specific funding distribution practices: potential costs and damages are largely hidden, whereas benefits are very obvious, as the attention of the scientific community, media and funders is focused on the winners of this game, and much less attention is given to the largely futile investments of the typically vast majority of losers in any given call. However, most research funding is intended for

scientific endeavors as such, not for the individual benefit of single players. The latter would be patronage, which is a perfectly welcome source of research support as well; however, it requires a subjective and proactive selection of the funding recipient rather than an open call for competing research applications. In addition, whether an open funding initiative is supportive or detrimental for science has to be decided with regard to its value not for single players, but for the scientific community as a whole.

On the basis of these considerations, at least two of the criteria used to define predatory publishing can be transferred to funding initiatives[15]: deviation from best practices and a lack of transparency. Whatever set of best practices for funding distribution one would consider sensible, the imperative that a funding initiative should not waste more resources of the scientific community than it adds should be among them—ideally the benefits should outweigh the costs *considerably*. To allow relevant stakeholders (individual applicants, the scientific community as a whole and the donors or taxpayers who provided the funding in the first place) to evaluate if this is the case, funding initiatives need to be transparent about the total costs of their funding distribution practices, including not only administrative overhead and reviewer/panel time investment, but in particular also the—so far largely ignored—costs on the side of unsuccessful applicants.

EVALUATING THE HIDDEN COSTS OF GRANT APPLICATIONS

We would like to stress this point: the majority of costs related to funding distribution do not accumulate at the level of reviewers and decision panels or the administration of the funder, but—at least in case of competitive calls—at the level of the large number of applicants. The administrative overhead of the largest German funding agency, DFG, lies at a very moderate 2.3%, which translates to less than €1000 administrative costs per application. While resources invested by reviewers and decision panels will likely exceed this number, the costs related to time investments on the side of the applicants can be expected to be considerably higher, despite a comparably generous success rate of 30–36%.[17] For most other grant schemes with lower success rates, these numbers look considerably more dire. One of the authors has logged about 1000 h of time investment as one member of a consortium writing a grant proposal for a Cluster of Excellence, the biggest funding scheme in Germany. It is thus worth emphasizing that large grant amounts do not automatically lead to positive expected values—large consortia with extensive proposals, competing for grants with funding rates below 5% (as in many European Union calls), will generate costs that might approach or exceed the mean expected return even for large grant sums.

Figures 1 and 2 quantify the extent of the problem from two different angles. Figure 1 shows the net return that an individual grant yields on average, as a function of the time invested in the proposal. The smaller the grant sum and the funding rate, the faster one reaches a negative net return: the cost of the principal investigator's time invested in the proposal exceeds the grant sum. For a €50 000 grant with 5% success rate, the net return is negative if applicants invest more than a total of nearly 50 h into developing the proposal, including drafting, communication with collaborators/administration and so on.

From the point of view of the academic funding system, the relevant quantity is the net return as a function of the funding rate, as shown in Figure 2. Depending on the grant size, the funding rate and the mean time invested in proposal preparation, the point of zero net return is crossed at funding rates that are not uncommon in the current funding landscape.

A zero net return corresponds to a situation where all funding is spent *solely* on the acquisition of funding—not a single hour of actual research would be funded. For funding rates below this break-even point, the net return rapidly becomes very negative—such grants effectively cost the academic funding system a substantial amount of money.

Only if the total grant sum considerably exceeds the costs of the distribution, that is, producing and evaluating grant proposals plus administrative overheads, does the grant actually support research; otherwise it effectively impedes it. A cynical implication considering contemporary developments of antiscience movements would thus be that an effective way of lobbying against certain types of research would not be open opposition, but to establish a funding organization that offers comparably small grants in combination with the usual extensive application procedures.

One might ask whether the entire time spent writing an unsuccessful proposal is in fact wasted. Depending on the discipline and type of grant, a varying fraction of work on the proposal might be recuperated because it can be recycled for other grants schemes or because the underlying conceptualization of a work program benefits the researcher or the field independently of the proposed research.[18] However, unless this fraction is close to 1, this will not significantly affect our argument. For example, if an average of 50% of the

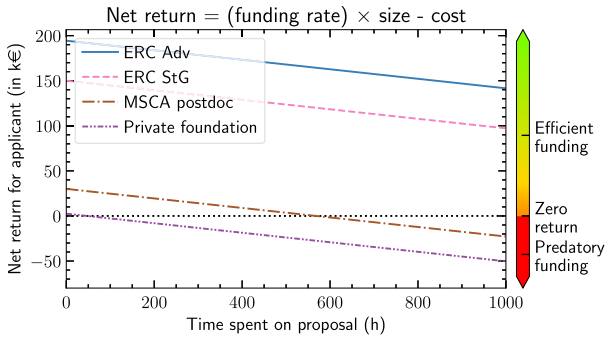

Figure 1. Mean net return considering success rates and required time investments for the ERC (European Research Council) Advanced (ERC Adv) grant (€2.43 million, 8%), the ERC Starting (ERC StG) grant (€1.5 million, 10%), the Marie Skłodowska-Curie Actions (MSCA) Postdoctoral Fellowship (€200 000, 15%) and a research grant by an unnamed, private foundation (€50 000, 5%). The even less efficient grant scheme described above in scenario C is not illustrated, as it results in negative returns for almost any realistic time investment.

time can be reused on a different proposal, then the net return (read from Figure 2) would increase the funding rate by a factor of 2.

ULTERIOR MOTIVES FOR GRANT APPLICATIONS

But why would any researcher apply for grants that are clearly inefficient? The first, obvious reason is that the base funding provided by their host institution is often not sufficient to realize the researcher's programs—or even to cover basic necessities such as travel and publication costs. This decline in base funding necessarily forces researchers to invest increasing amounts of time to compete for grants, which in turn increases the competition in the system. Moreover, many researchers apply for funding for ulterior motives: because they are pressured by their institutions, who are in turn often ranked by the amount of aggregated funding; because grants are used as criteria for internal resource allocation; because grants are part of tenure evaluations or more generally, because receiving a given grant is important for the researcher's career advancement or standing in the field. In addition, the aforementioned "Matthew effect" might exert financial incentives beyond the targeted grant: succeeding in a small, ineffective grant might increase the chances of getting the next bigger grant. All these ulterior motivations might be legitimate on the individual level; however, they are not the reason why competitive funding was established. They thus lead to a misalignment of the interests of society and individual researchers. In particular, these motivations can lead researchers to invest time in the aforementioned inefficient grants.

Such ulterior motives can also play an important role for some funding agencies: many funders are interested in the prestige of their grants, which is partly tied to their competitiveness. As the bulk of the costs of the funding distribution—thousands of hours applicants spend on writing proposals—are not paid by the funders, their interests are thus not necessarily aligned with those of the research community or society as a whole. Despite their best intentions, some funders effectively draw money from the scientific community, and thus act as predators in the academic ecosystem.

In the following, we outline five specific recommendations to remedy this unsatisfactory situation, ordered from the simple to the more ambitious.

RECOMMENDATION 1: FIRST CALCULATE, THEN CALL/APPLY

If the main goal is to support research, our above arguments suggest that all funding agencies should make sure that any call for applications is effective rather than predatory: it should be expected to pour more resources into the scientific community than it draws from it, considering all costs on the side of potential applicants. Even if reliable numbers are not available in a given case, funders should still calculate with the best evidence or prognoses possible. If the expected value of a planned call for the academic community is not clearly positive, the funder should abstain from an immediate call and consider alternatives. While "burning the money in the backyard" might actually be a positive alternative compared with publishing a call with a negative expected value, more reasonable options can be envisioned as well. For example, teaming up with other funding agencies would increase the amount of funding and thus the expected value; a more specific research focus would decrease the pool of potential applicants, which would simultaneously enable funding agencies to steer research into directions of interest.

The recommendation "First calculate, then act!" is directed at researchers as well. An informed decision for or against starting a grant application process should be made only after weighing the funding amount against the success rate and all expected costs of the grant application, and after a critical reflection of potential ulterior motives in case the expected value of

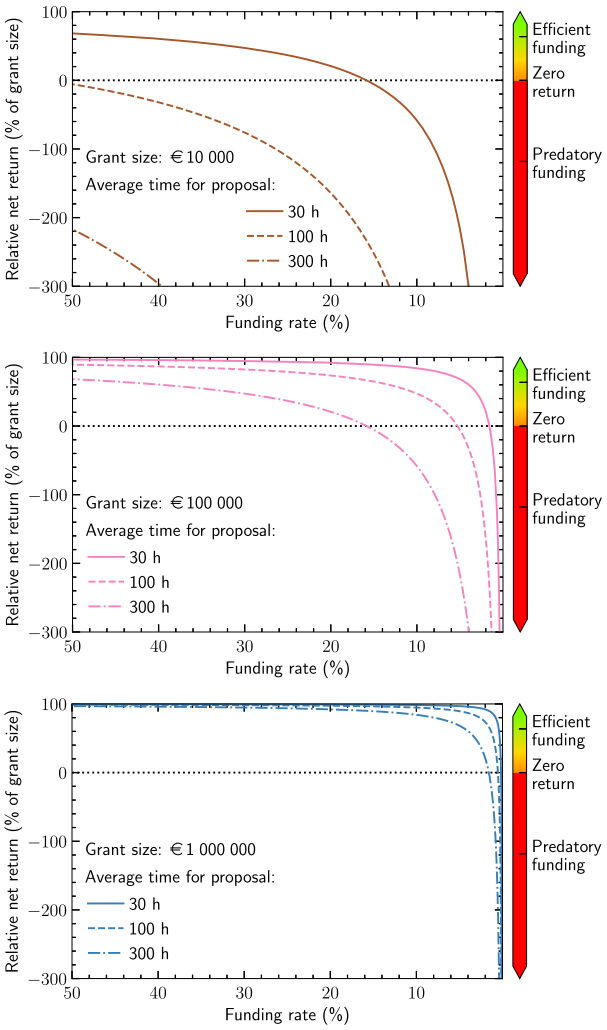

Figure 2. Expected net return per application in percentage of the grant size as a function of the success rate, for different time investments. As a general rule, given low success rates, the lower the size of a grant, the more likely it is to lead to a negative net return for the scientific community. All calculations assume a representative annual salary cost of €90 000.

the application is not clearly positive. We provide a simple calculation tool for such considerations online: f.unding.com.

RECOMMENDATION 2: INCREASE TRANSPARENCY

To allow researchers to perform their own cost/benefit analyses before applying to a grant, they need to have accurate figures of funding rates at their disposal. Accordingly, funding agencies need to be able to assess the amount of time spent on writing proposals for a given grant. A sensible best-practice demand thus is to evaluate and publish accurate and up-to-date numbers on the efficiency of funding opportunities: the success rate in previous calls, as well as the average time spent on a proposal, based on input requested from applicants. This would further allow funding agencies to adapt or remove grants that are not efficient.

This call for transparency also applies to information given to donors and taxpayers. While many foundations are open about their overhead costs, potential supporters are likely interested in how much of their donation is effectively invested in actual research, after subtraction of all costs including not only administration on the side of the funding body, but also distribution costs on the side of the targeted research community.

RECOMMENDATION 3: REDUCE TIME SPENT ON PROPOSALS

For a fixed amount available to a given funding agency, the most direct way to increase efficiency is to reduce the costs produced by the call, in particular the expected time spent on proposal preparation—or, more radically, to eliminate proposals entirely. Clearly, the smaller the grant sum, the less time should be necessary to compose a fundable proposal. Beyond reductions of the expected proposal length, simple and streamlined formats, standardized across different funding instruments and agencies, would minimize unnecessary time spent on formatting. Two-stage reviewing processes with very brief expressions of interest in the first stage, and a restricted number of applicants in the second stage, would further alleviate the issue. Finally, in case of rejection, grant agencies should provide detailed feedback and allow resubmission of any proposal that is deemed fundable. After all, writing grant proposals consumes much more time than the review process does, even when including the effort of providing feedback.

RECOMMENDATION 4: REMOVE ULTERIOR MOTIVES FOR GRANT APPLICATIONS

A desirable approach to removing unnecessary grant applications, and thereby increasing the efficiency of

the funding system, is to remove ulterior motives for grant applications. If individual researchers as well as institutions were not ranked by the amount of third-party funding gained, this would remove the pressure to apply for grants solely to satisfy evaluation criteria. The reduced number of proposals would directly increase the efficiency of the system by a substantial amount.

As an intermediate step, evaluators could base their rankings of individuals and institutions only on efficient grants, as evaluated based on the published numbers proposed above. This would ameliorate the issue, as the pressure to write proposals would shift to those grants for which there is a reasonable return on invested time. This will also make the funding system more dynamic, evolving toward an equilibrium between efficiency and attractiveness of offered grants.

RECOMMENDATION 5: ADOPT ALTERNATIVE FUNDING DISTRIBUTION STRATEGIES

To overcome the issues of the current funding system as mentioned in the introduction, several alternatives to the current funding distribution system have been suggested in recent years. The simplest solution would be to provide every member (perhaps above a given career stage) of a certain academic community with the *same amount of funding*. A very efficient starting point would be to increase the base funding of research institutes to allow a minimum of necessary research activities, such as limited travel and publication costs. While this base funding is not distributed based on competitive criteria, it frees up part of the substantial fraction of work time of many researchers currently spent on grant applications. A more predictable funding distribution would further support long-term research programs rather than boom-and-bust phases of volatile short-term grants. Recent calculations show that the resulting base funding with equal distribution is substantial,[19] and would receive considerable support by the academic community,[20] even among high-performing researchers.[21] Maybe most importantly, scientific systems with increased base funding compared with competitively distributed funding appear to produce stronger research outputs.[11] In case funders are concerned about quality control before the funded research is performed, ideas about postponed, noncompetitive peer review for research projects might be adapted.[21] Larger projects would still be feasible as collaborations of multiple principal investigators who pool their funding. If stronger accumulation of funding is required without agreement between collaborators, the increasingly discussed concept of a *funding lottery* might serve as an objective, transparent and efficient solution to allocate large batches of funding on few researchers rather than distributing it equally.[22] To keep some degree of competition and reflect the perceived research excellence within the field, the concept of *peer-to-peer funding* would allow for an efficient solution[23–24]: again, funding is distributed equally; however, every researcher has to redistribute a certain share of their funding to (noncollaborating) colleagues whose research they deem excellent. Such a system might be particularly beneficial in time-critical cases where the relative efficiency is not the only concern, such as the current coronavirus disease 2019 (COVID-19) crisis: rather than investing months of grant writing and evaluation procedures, the scientific community could in principle decide within days on which groups have the strongest expertise to achieve a pressing research target.

CONCLUSIONS

The actual amount that a competitive funding scheme makes available for research has to factor in the cost of applying for the grant—by all applicants. We showed that if the grant is small, the net amount provided for research quickly becomes negative with decreasing funding rate: more working time of the academic community goes into applying for this grant than is generated by the resources that are funded.

There are several simple remedies that could help with this unsatisfactory situation: make funding rates transparent for all grants, so that researchers can decide how much time to invest in proposals; and simplify application procedures. The smaller the grant, the less effort it should take to compose a proposal. This implies that very small grants are generally very inefficient, and might be better replaced by a reasonable level of base funding. These measures are simple to implement while maintaining the current structure of funding distribution. A further important step is to remove ulterior motives for applying for grants, such as rankings or promotions based on acquired research funding. After all, funding schemes exist to enable research, rather than the other way around.

Beyond these improvements to the current system, we believe there is ample reason to consider alternative funding distribution strategies instead. Increasing base funding of universities might be the simplest and most efficient solution; however, in cases where this is not an option, a distribution of research awards to selected researchers, funding lotteries or peer funding

would be efficient alternatives. In practice, the most appropriate solution is likely a combination of some of these options, depending on the goals of the funding initiative, and probably with different combinations in different research areas, perhaps at different seniority levels to avoid biases against junior and/or underprivileged members of the community. A tailored mixture of different funding strategies might be able to address multiple pressing issues with the current state of research funding at once. Although some of the proposed solutions might be intrinsically difficult to combine—for example, reducing the applicant pool and allowing resubmissions—we believe it is time to seriously consider these options. In the face of the current costs and inefficiencies of the system, any effort in this direction will surely pay off for research as a whole.

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AUTHOR CONTRIBUTIONS

Martin Dresler: Conceptualization; writing – original draft; writing – review and editing. **Eva Buddeberg:** Conceptualization; writing – original draft; writing – review and editing. **Ulrike Endesfelder:** Conceptualization; writing – original draft; writing – review and editing. **Jan Haaker:** Conceptualization; writing – original draft; writing – review and editing. **Christian Hof:** Conceptualization; writing – original draft; writing – review and editing. **Robert Kretschmer:** Conceptualization; writing – original draft; writing – review and editing. **Dirk Pflüger:** Conceptualization; writing – original draft; writing – review and editing. **Fabian Schmidt:** Conceptualization; writing – original draft; writing – review and editing.

CONFLICT OF INTEREST

All authors have an interest in an efficient and fair funding system. Other than that, the authors declare no competing interests.

DATA AVAILABILITY STATEMENT

All data, code, and materials are available from the authors without restrictions.

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