Quality criteria and concentration of research funding

Across many countries concentration of research funding is becoming more pronounced affecting both diversity and topic selection. What is driving these developments? And what are the arguments for and against increased concentration? We address these questions in this Policy Brief and highlight how differing notions of research quality can be both a central driver of concentration and a possible remedy for potential negative effects.

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1. Trends towards funding concentration

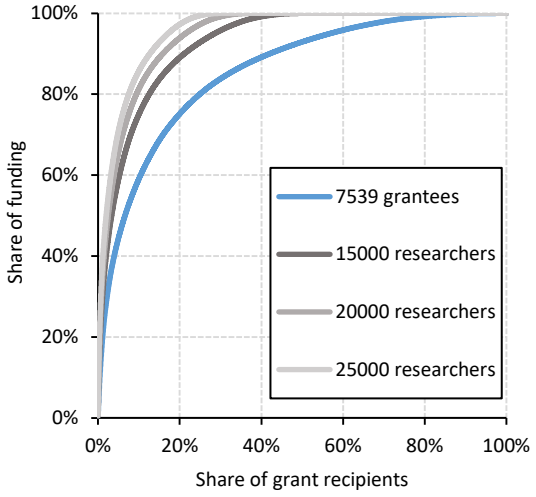
Allocation of research funding is an influential element in governing contemporary science, affecting the scope, content, direction and impact of public research (e.g. Sörlin 2007; Gläser and Velarde, 2018). More pervasive competition, increased performance orientation, stronger emphasis on excellence, and higher reliance on project funding are seen as essential to optimize returns on public investments in science in many countries. These and related developments are likely to affect the balance between concentration and dispersal of the available funding. A central question is therefore: **Do large shares of funding allocated to a small number of scientists yield most value for money? Or is scientific progress and support for societal needs better served by allocating fewer resources across more numerous teams and more diverse research topics?**

These are vital questions given recent research indicates growing funding concentration: Bloch and Sorensen (2015) report a trend towards funding concentration at both individual and group level across a range of countries. Katz and Matter (2019) find funding inequalities in the US National Institutes of Health have increased considerably between 1985 and 2015, with a small segment of investigators and institutes accumulating an increasing proportion of funds. Two Canadian studies (Lariviere et al. 2010; Mongeon et al. 2016) find the same trends across a broad range of fields, and Ma et al. (2015) show similar patterns for UK engineering and physical sciences. However, evidence is still scattered and concentration trends may play out differently across countries, fields and specialties. Nonetheless, **a thorough examination of concentration, how it develops and its potential consequences seems both necessary and timely.**

2. Concentration of Danish research funding

To examine the full degree of concentration within a specific national system, we recently collected funding information for almost 20,000 grants allocated by 15 of the largest public, private and non-profit Danish research funding foundations during 2004–16 (Aagaard, Schneider & Andersen 2019). Here close to 53 billion DKK (7 billion Euro) was allocated to nearly 7,500 PIs (only main grant holders were counted). Our analysis shows that among the grantees alone, the top 20 percent accounted for 75 percent of the allocated funding. Even with a conservative estimate of the full Danish population of public researchers (above PhD level), **the 20 percent of most successful grantees received almost 90 percent of allocated funding.**

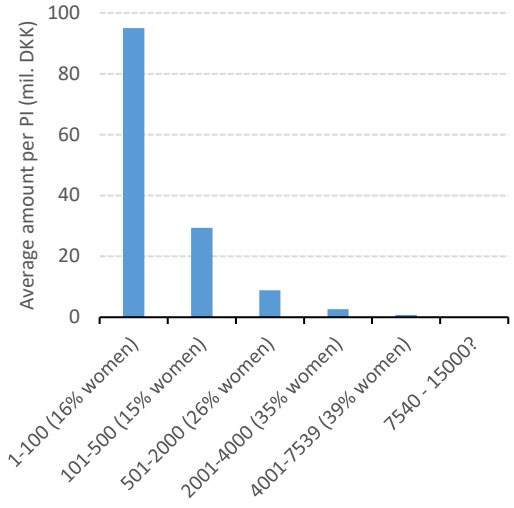
Figure 1: Cumulative distribution of Danish research funding allocated across 15 foundations, 2004-2016



**Blue line shows grant recipients only. Greys lines show different estimates of the population of public researchers during the period*

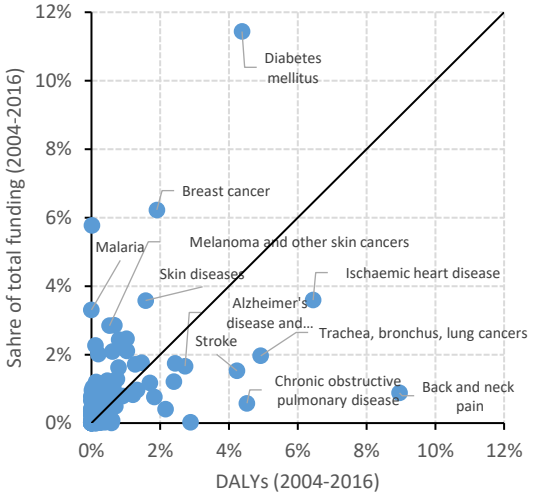
A similar picture is observed when recipients are ranked in groups based on their sum of received funding. Figure 2 shows that the top 100, measured on grant success, received an average amount of just below 100 million DKK, while the 101–500 group received an average sum per person slightly below 30 million DKK. Beyond the first 2,000 grantees the amounts secured per person become very limited or non-existent. We also see women only accounting for 15–16% of all grantees in the top two groups. The proportion of women increases for the following groups but only as average total grant amount decreases. **In other words, concentration also seems to amplify gender biases**.

Figure 2: Ranked groups based on total funding received during 2004-2016



However, concentration of funding not only has a gender bias, it also influences the selection of research topics. To examine this, we conducted a more detailed case study on funding of disease-specific research. Here, we correlated funding patterns with so-called DALY (disability adjusted life years) measures developed by the WHO (Madsen & Aagaard 2019). Obviously, these measures cannot alone determine research priorities. But they arguably provide some indication of societal needs, which should be taken into account. Figure 3 shows very weak correlations between investment levels and the societal burden of specific diseases. Some disease specific topics, especially diabetes and breast cancer, are substantially overfunded respective to their DALYs; other diseases garner scant funding relative to their societal burden. These patterns indicate that concentration towards certain disease research topics is not driven primarily by societal needs, i.e. by the proportional social burden related to those diseases.

Figure 3: Correlation between funding of disease specific research and DALY's



This disparity between apparent needs and concentrated investments corresponds to evidence we have previously seen elsewhere (e.g. Evans, Shim, & Ioannidis, 2014; Jones & Wilsdon, 2018). Perhaps more surprising is the similarity of topic priorities across funders. In the Danish context, it could for instance be assumed that the observed patterns for diabetes and breast cancer are mainly driven by some of the influential non-public funders with particular interests, e.g. the pharmaceutical foundations and the Danish Cancer Society, respectively. These foundations do indeed play a significant role in funding the most well-funded diseases. However, our analysis shows that the majority of funding actually still comes from the public foundations. Hence, **multiple foundation types mirror each other's priorities rather than perform different or complementary roles within the funding landscape**. Recall that these overlapping priorities do not strongly correspond to the burdens of societal needs, so they appear to be driven by other factors.

3. Drivers of concentration

As shown, concentration of Danish research funding is quite pronounced with apparent consequences for the research population as a whole, for gender equality and for topic selection. This concentration is especially surprising since the Danish system historically has been considered highly egalitarian. This gives us reason to presume we may find similar or greater concentration in other national contexts with comparable or lower egalitarian features. An

important question then is how this high degree of concentration might be explained. **There is however no single simple explanation, but most likely rather a number of interacting causes reinforcing each other**. Firstly, the institutional structure of science is itself biased toward concentration – even in cases where external pressures are absent (Merton 1968). However recent policy changes in funding and assessment of science likely have amplified this inherent bias. On the one hand we see conscious and deliberate research policy choices; e.g. larger grants, support for critical mass and initiatives to create 'world leading' environments. But funding concentration may on the other hand also be the result of less obvious, less deliberate factors. Two seem particularly important. The first concerns dominant research quality criteria. When different funding agencies operate with relatively uniform criteria based on narrow notions of excellence (typically judged by elite peers supported by metrics like h-indexes and journal impact factors) **priorities are likely to be mirrored even across fairly different funders**. Hence, when a majority of funders aim to pick and fund the 'best' researchers based on these similar quality criteria, the result will be increased concentration. This tendency is likely further amplified by a second factor: a lack of oversight of allocation decisions made elsewhere in the system. Lack of coordination and transparency within and across grant bodies may in other words result in higher concentration than any single funder aims. Even if each single grant decision in isolation is sound, systemic effects may be undesirable when the majority of the funders select using identical parameters with many funders inadvertently ending up funding the same researchers and the same narrow topics. Hence, **a combination of strong competition, large grants, low success rates, many competing funding organisations selecting using similar one-dimensional excellence criteria and lack of coordination is likely to foster undesirable levels of concentration**. And yet exactly these features and dynamics appear widespread and rising in many national funding systems around the world.

In Denmark these characteristics have defined the funding landscape's development for the past 15 years. The share of project funding has increased from less than a third of total research funding to nearly half. **Grant sizes have grown, success rates have dropped, and a drive for excellence has intensified across both public and private funders**. Private foundations often have specific topic interests and aim to establish and support highly visible, impactful research groups and topics. These thereby gain an upper hand within the broader competition for public funding. **This trend is further amplified when the most successful grant recipients subsequently also get rewarded with additional institutional funding via performance-based internal funding allocation criteria**. And so the cycle continues and perpetuates even further concentration.

R-QUEST Policy Briefs

Centre for Research Quality and Policy Impact Studies (r-quest.no) is devoted to studies of the notion of research quality, conditions for high quality research and its effects on the society. Future R-QUEST policy briefs will communicate results from this research–.

R-QUEST is sponsored by the RCN's FORINNPOL programme for the period 2016-2024. It is managed by NIFU and involves a number of research partners as well as policy/user partners.

4. Pros and cons

Given all this, we might ask then what levels of concentration might actually strengthen the academic and societal impacts of the science system as a whole? Here we conducted a literature review focusing on scholarly arguments for and against increased concentration of funding (Aagaard, Kladakis & Nielsen 2019).

Some arguments clearly favour at least some degree of concentration. First, we find a classical meritocratic argument that scientists with greatest potential to produce (potentially) path-breaking research should be rewarded according to their abilities. Economies of scale, critical mass, access to expensive instrumentation are also marshalled here as arguments for concentration. Funding concentration is furthermore argued to give increased flexibility to researchers, allowing them to take risks and pursue their research process with long time horizons. Other arguments highlight spillovers (the 'trickle down' argument), recruitment and collaboration effects. These all seem rather strong arguments and yet there are indications – as we return to below – that many of these apparent benefits might also be achieved with more moderate degrees of concentration without the potential systemically counter-productive effects of overly high concentration.

In support of dispersal rather than concentration we find arguments that supporting many lines of inquiry spreads risk and increases chances of breakthroughs by allowing for a broader variety of perspectives, interpretations, heuristics and predictions. Likewise, chances of serendipity also increase with a multitude of competing approaches. Dispersal at the same time likely secures better alignment with broad societal needs whereas concentration based on narrow excellence notions focuses scientists' attention inwards rather than on problems of the 'outside' world. Dispersal is furthermore perceived to foster resilience in constantly changing research systems, where concentration on the other hand can lead to stagnation and reduced systemic adaptability. Another argument is to avoid large self-perpetuating research units that reduce the capacity of the system to respond flexibly. Concentration is also argued to turn group leaders into 'science managers' with little time for research and mentoring and with overly strong incentives and pressure to apply for and obtain ever more resources than can be productively spent. Dispersal alternatively is argued as supporting a broader knowledge pool, creating absorptive capacity across systems as a whole and underpinning research-based teaching across all disciplines. In doing so, it may also secure a strong future growth layer of early and mid-career researchers and keep a broader group of researchers and students active in research. Finally, dispersal is argued as preferable over concentration as it reduces trends towards hyper-competition, and may mitigate a peer review system that is perceived as unreliable, subject to a number of biases and often unable to identify the most promising projects.

5. Balancing dispersal and concentration

Numerous empirical studies have shown that, on average, there is declining marginal return on each Euro invested in research above a certain threshold. This threshold varies across disciplinary and national boundaries. However, it is not – generally – very high. And these studies only examine concentration from a metrics point of view. Adding the concerns highlighted above the case for increased dispersal may seem even stronger. However, reducing ideal or optimal funding to a simple question of evidence for or against concentration would oversimplify a complex, multifaceted problem. The 'proper' balance between funding concentration and dispersal of research funding is more a matter of degree: **both too little and too much concentration appears inefficient in both economic and epistemic terms**. Similarly, studies also indicate that a healthy research system ecology includes both large and small groups. However, the literature we have reviewed still presents a fairly strong case against high concentration. There are clear indications that most countries and fields need less, not more of it. Policymakers obviously worry about spreading out available funding too thinly, and whilst some selectivity certainly is justified due to differences in talent and originality across populations of researchers and due to differing expected impacts of various research topics, most systems currently have seemingly moved too far towards high concentration. There is therefore a need to consider how to calibrate these systems better to secure more healthy balances between concentration and dispersal. A number of suggestions are found in the literature:

First, better oversight is needed within and across funding organisations to ensure allocation decisions are more based on broad portfolio perspectives and less on assessments of individual applications in isolation. Secondly, **experiments are needed with funding mechanisms seeking to counter the concentration bias** associated with large parts of current allocation systems. A radical proposal here even suggests using a modified lottery model for grant applicants who pass an initial quality screening (Fang & Casadevall 2016). Others suggest experimentation with new funding instruments to promote risky research and diversity, for instance by fully blinding the review process. But **most importantly, there is a clear need to start operating with a broader understanding of research quality**. Here we must acknowledge more explicitly that 'excellence' is multifaceted and multidimensional. Allocation mechanisms must be better equipped to capture and reward this inherent variety of academic and societal dimensions.

Real changes will require political will and courage from both public and private funders. Recent Danish experiences suggest that private foundations actually are beginning to take a different view of concentration and dispersal. So far, the implement-ted changes are only affecting the margins of the system, but more may be coming.

Policy implications

The policy implications of the examined patterns and drivers of concentration are important. They question the rationale behind current funding trends and may point towards more efficient ways to allocate research resources.

- A strong excellence orientation is likely to create self-reinforcing mechanisms rewarding already successful researchers and assign even more funding to research topics that are already very well-supported.
- While this may be justified at the level of each funded project, it may still be undesirable from a systemic perspective.
- A highly excellence-oriented system may in addition further reinforce overly rigid disciplinary boundaries and detach research from broader societal needs.
- Funders operating with broader notions of research quality and experimenting with alternative funding mechanisms may on the other hand make it possible to support more diverse, flexible and resilient research systems.
- Such systems may both increase chances of scientific breakthroughs as well as promising better alignment with pressing societal needs and expectations.
- Hence, policies leading to better balances between dispersal and concentration are not only preferable from a scientific perspective, but also likely to be more aligned with values of a democratic society and with the political system that provides the resources in the first place.

Further reading

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