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Maneuvering through a Changing Funding Terrain: Biomedical University Scientists in Positive and Negative Feedback Loops

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Abstract

The mechanisms of research funding are in flux across the Organisation for Economic Co-operation and Development (OECD) countries. In Denmark the research system has experienced an increase in the concentration of research funding on individual researchers and topic areas. This article documents such concentration patterns in biomedical research and applies a case study methodology to explore some of its consequences. The study contrasts the markedly different funding environments of two sets of biomedical researchers at the same public university. One set of scientists has benefited significantly from working in specialized research centers sponsored by private funds. The other, located at a conventional university department has been adversely affected by the changing funding logic of the Danish research system. We compare the two sets of researchers with regard to: 1) how they perceive their funding conditions to have changed in recent times, 2) what coping strategies they rely on, and 3) how they perceive this to impact their "problem choice." Our analysis shows how scientists, as a consequence of rising competition over funding and growing resource concentration on fewer research specialties (of particular interest to private funders), perceive considerable pressure to adapt their research activities. The perceived impact however differs substantially across informants.

Keywords

research funding; university scientists; biomedical research; coping strategies; problem choice; resource concentration

Introduction

The interplay between research funding, the conduct of research and its epistemic content is a longstanding topic in STS (e.g., Laudel and Gläser 2014; Rip 1994). Since the 1980s, spending on public R&D has risen considerably among OECD countries (OECD 2019). However, not only has the volume of investments increased, the way in which resources are allocated has also changed considerably (Wang, Lee, and Walsh

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2018; Whitley, Gläser, and Laudel 2018). One of the most significant developments in the funding of public research has been the gradual replacement of institutional funding with a growing share of competition-based funding (Aagaard 2017; Heinze 2008; Heinze et al. 2009, 620; Hessels et al. 2011, 558; Lepori et al. 2007; Luukkonen and Thomas 2016, 100). The latter includes public funding from research councils and agencies as well as funding from philanthropic foundations and private research funding organizations (RFOs) (Heinze et al. 2009; Hessels et al. 2011, 620; Kundu and Matthews 2019). As a consequence, scientists are increasingly reliant on external funding stemming from a wide variety of sources (Aagaard et al. 2021; Calhoun 2006, 27–8; EC 2015; Hessels et al. 2011, 563; Leisyte and Dee 2012, 143). Research funders and university managers are generally keen on increasing streams of external funding. However, the epistemic consequences of a growing share of external funding for conventional universities are still underexplored. This makes it pertinent to explore not only the direction and magnitude of the funding changes but also the consequences on research practices as experienced by active scientists.

In this article, we present a mixed methods explorative analysis of how scientists seek to adapt to ongoing funding changes with a particular focus on the role of growing private funding. Moreover, we examine the degree to which these changes in funding is perceived to influence the direction and content of the research conducted by a select number of scientists. We initially document a rise in competitive project funding in the Danish research funding system, as well as growing resource concentration on individuals and topics—partly as a consequence of growing private funding. We use these changes as the backdrop for a small-*N* qualitative case study carried out among biomedical researchers at the University of Copenhagen in Denmark, allowing active scientists themselves to articulate how they perceive developments in their own funding conditions. The University of Copenhagen is at the forefront of biomedical research globally and thus represents a good site to investigate a local manifestation of a potentially more widespread trend in the funding of research more generally and medical research in particular. Notably, it is a suitable context to explore how changing funding dynamics impact not only on the science-internal dynamic of prestige and recognition, but also on the balance between research and teaching. The case study is designed as a comparison between two sets of biomedical scientists that have been affected in markedly different ways by recent changes in research funding. As a consequence, they assess their situation and ability to maneuver in an increasingly competitive funding terrain very differently.

Our study does not seek to establish a causal link between funding conditions and scientific practices. These practices may be contingent on a host of factors beyond our study. Nonetheless, we find it pertinent to investigate how researchers perceive and adapt to ongoing changes in research funding. The analysis hence zeroes in on how researchers with different funding conditions respond to and experience changing financial circumstances, that may over time accumulate significant epistemic consequences.

The paper is structured as follows: First, we highlight existing research on how scientists respond to ongoing changes in the funding landscape. Second, we account for the methodology of our study. Third, we report the findings of our analysis in four major parts, respectively addressing: 1) *recent developments* in the funding of Danish research, 2) how the two sets of scientists experience their *working conditions*, 3) what *strategies* they adopt to navigate these circumstances, 4) and how they experience these to *influence their topic choice*. In the final section, we draw conclusions, discuss the implications of our findings and suggest avenues for further inquiry.

Conceptualizing the Effects of a Changing Funding Landscape

Sociologist of science Richard Whitley and colleagues (2018, 110–11) recount four significant financing and governance changes with implications for the allocation of public research funding: 1) increasing demands for external funding, 2) a shift towards strategic rather than blue-sky research, 3) increasing attention to performance indicators and evaluations, and 4) increasing expectations that results are readily commercializable. A key rationale behind more recent funding priorities has been the perception that the overall quality and impact of research will increase through competition and selective funding of the best performers (Hicks and Katz 2011). The question of how such changes in funding patterns impact the content of research however continues to be a matter of both scholarly contention and empirical research (Franssen et al. 2018; Gläser and Velarde 2018; Hove 2020; Sarewitz 2016). Studies suggest that academic scientists, as a response to intensified demands to attract research funding and publish more frequently, employ a number of *coping strategies* (Hessels et al. 2011; Laudel 2006a, 2006b; Leisyte and Dee 2012). For instance, "framing" of research is highlighted to play a significant role as exaggerations of the importance of proposals and results may improve the chances of (funding) success (Andras 2011, 94; Ziman 1987, 94). Similarly, Liudvika Leisyte (2007), Terttu Luukkonen and Duncan A. Thomas (2016), and Sheila Slaughter and Gary Rhoades (2004), find that scientists in attempts to attract grants seek to fit their work within areas that comply with the preferences of funding bodies. However, studies also suggest that a multiplicity of funders and funding instruments may create new opportunities, as researchers are able to "court multiple funders," engage in "opportunistic portfolio building" (Morris 2003), and "'pick and mix' among schemes and funding sources" (Morris and Rip 2006, 259). In this paper, we explore these issues within a Bourdieu-inspired analytical framework. Pierre Bourdieu suggests that science can be analyzed as a hierarchically structured social space, i.e., a "field" where actors struggle to maximize different kinds of "capital" (McGuire 2016; Bourdieu 1975, 1986).

In the existing literature considerable attention has been accorded to how changes in the allocation of research funding affect problem choice (e.g., Gieryn 1978; Hellström and Hellström 2020; Mulkay and Edge 1973; Ziman 1981, 1987; Zuckerman 1978). Problem choice designates the decision by an individual scientist to carry out a specific program of research on a related set of problems (Cooper 2009, 634 following Gieryn 1983, 97). Such decisions may be influenced by a host of factors, including expected academic returns, feasibility, possibilities to publish results, ability to acquire funding, costs of doing research, etc. (Cooper 2009; Leisyte and Dee 2012). While the simple availability of money does not generate particular findings or commercializable results, the possibility to attract funding (or not) may influence scientists' choice of research problems (Gläser and Laudel 2016; Vallas and Kleinman 2008; Whitley et al. 2018). Thus, while this possibility to "guide" research interests in particular directions through funding may seem desirable from the point of view of funders and policy makers, scientists may perceive this as an encroachment on their scientific autonomy. This autonomy largely hinges on the ability to establish what Whitley et al. (2018) call "protected spaces," or what Luukkonen and Thomas (2016) refer to as a "negotiated space." Luukkonen and Thomas (2016) suggest that:

> [W]hilst remaining important, university governance and funding organizations have a subtle, more nuanced and mediated—what we have called 'negotiated'—influence on research topics selection and research agenda formation than is often suggested. . . . Topic selection is by and large an outcome of

> researchers' preferences, but how researchers conduct research is quite open/vulnerable to the—negotiated—influence of funders' preferences and requirements, and to the changes and chances of a researcher's funding success. (ibid., 124)

As the quote suggests, the influence of changing funding conditions is mediated in intricate ways by what can be considered "science-internal" criteria of success and the associated mechanisms of allocation of recognition and rewards. Robert K. Merton (1968) coined the term "Matthew effect" to describe how scientific success and recognition tends to concentrate disproportionately among a small number of successful researchers. Bruno Latour and Steve Woolgar (1986) similarly suggested a "credibility cycle" of scientific success. The credibility cycle captures how initial success through successive steps may lead to a positive feedback loop that establish some scientific results and some scientists as credible, leaving others behind in a similarly negative feedback loop (Laudel 2006b, 398; Leisyte and Dee 2012, 151). Funding bodies may thus either reinforce and amplify science-internal hierarchies and stratification processes (Aagaard et al. 2020; Bol et al. 2018)—or they may modify and upset internal criteria. It therefore seems relevant to ask if and how the Matthew effect might be modified in a changing funding regime where private funding gains in significance.

Methods and Data

In the results section we first examine recent trends in Danish research funding. Here we draw on official statistics as well as a recently published study by one of the authors of this article examining the allocation of Danish research funding across 15 different public and private research funders. Based on this material we examine both aggregated trends and more specific developments within the biomedical area.[1] On this background we use qualitative interviews to examine how the changing funding landscape is *experienced* by scientists as they attempt to negotiate a protected epistemic space for their work (cf. Luukkonen and Thomas 2016).

Our case study is structured as a comparison of the perceptions of two distinct sets of biomedical scientists—many of which are sitting literally across the hall from each other—at the Faculty of Health and Medical Sciences, the University of Copenhagen. One set consists of scientists working at a traditional academic department with close links to the training of medical students. The department is supported financially by institutional funding and smaller project grants. The other set consists of researchers working in two highly specialized research centers located outside the conventional department structures and with no formal ties to the training of students. The centers are primarily funded by two multimillion ten-year grants from the same private foundation associated to one of the largest pharmaceutical companies in Denmark. We refer to the two sets of researchers as, respectively, "department scientists" and "center scientists." The department scientists tend to struggle to fund their research activities, whereas the center scientists have easier access to research funding. The selection of the two samples was done based on our

[1] For further information about the data and methods underlying these analyses see Madsen and Aagaard (2020a).

initial knowledge of the financial situation at both places prior to our interviews. This prior knowledge also informed the basis of our selection of informants.

The case study approach is chosen in order to acquire in-depth knowledge about how funding is *perceived* to affect the coping strategies of biomedical scientists at the University of Copenhagen in Denmark (cf. Heinze et al. 2009, 611; Hessels et al. 2011, 557). Accordingly, we explore both the perceived practical and epistemic consequences of changing funding priorities in one specific university context. The comparison of two sets of researchers serves to explicate any differentiated responses to funding circumstances while keeping the organizational context constant. Finally, we also explore how this impacts on the relationship between research and teaching, given that teaching is generally considered a less prestigious activity—at least within the Danish university sector.[2]

Ten in-depth interviews were conducted with biomedical scientists located at three different research sites at the faculty.[3] Five informants were based at the department, while respectively three and two of the informants came from the two privately sponsored centers. The interview sample is stratified with regard to academic age, spanning scientists at both early-, mid-, and late-career stages, i.e. from postdocs and associate professors to full professors. The distribution of the interview sample is displayed in table 1.

The topics covered in the interviews were organized according to the three main research questions, i.e. enquiring into how the funding situation affects their working conditions, how they adapt to their present circumstances, and finally how their coping strategies might impact on their choice of research problems, methods and publication strategy.[4]

As a final methodological remark, we note that while we prepared for the conversations with the scientists by getting acquainted with their research fields, doing CV searches and scrutinizing their publication lists, we are not experts in biomedicine (cf. Laudel and Gläser 2007).[5] As such we are not qualified to assess whether relatively "unsuccessful" scientists are unsuccessful either partially or primarily due to adverse funding circumstances or because other scientists are simply more talented or doing better research as judged against the field-specific standards (Laudel and Gläser 2014). Subjective experience may diverge from objective circumstances. Scientists may thus misrecognize the "true" causes of their placement in the scientific field. Hence, we can only report on the perceived effects of (changing) funding circumstances as articulated in our interviews. We find, however, that there is a high degree of correspondence between the reported experiences and recent changes in the funding situation to make the accounts plausible net of any intrinsic differences in scientific talent, etc. In support of this interpretation, we note that the privileged

[2] The Danish higher education (HE) system is a so-called binary system with a clear distinction between research universities on the one hand and teaching oriented university colleges on the other. In the former category, which is also where our case organization is to be found, research achievements are considered more meritorious and important for career advancement than teaching experiences.

[3] The interviews were conducted at the Faculty of Health and Medical Sciences at the University of Copenhagen during the fall of 2016.

[4] Details on specific institutional affiliation, research specialties and names of private foundations have been omitted to ensure anonymity of the interviewees.

[5] For a more elaborate discussion on "scientifically informed interviewing" see Laudel and Gläser (2007, 98).

center scientists recognized that their favorable circumstances are not attributable to talent and scientific merit alone, but also to the fact that they work in areas prioritized by dominant funding bodies.

Table 1. Interview Sample

Interviewees	Academic rank	Main field	Nationality
Department			
#1	professor	natural sciences	Danish
#2	associate professor	natural sciences	Danish
#3	associate professor	natural sciences	Danish
#4	associate professor	health sciences	Danish
#5	postdoc	natural sciences	Danish
Centers			
#6 (C1)	professor	natural sciences	Danish
#7 (C1)	associate professor	natural sciences	Danish
#8 (C1)	postdoc	natural sciences	Foreign
#9 (C2)	professor	health sciences	Danish
#10 (C2)	associate professor	natural sciences	Foreign

Findings

The results section is divided into four main parts, addressing: *changes in the Danish funding system*, active researchers' perceptions of developments in *research conditions*, the *coping strategies* employed and finally the perceived *topic choice effects* of the different funding circumstances of the two sets of scientists.

Rising Private Funding and Resource Concentration on Individuals and Topic Areas

The public budget for science in Denmark grew substantially from 2006 to 2013 (Uni. DK 2016), but stagnated from 2013 to 2017 (Aagaard 2017; Uni. DK 2016). Despite this stagnation, Denmark heads the OECD with the highest level of investments in public sector R&D as a percentage of GDP and ranks second when it comes to investments made in university sector research by private foundations and non-profit organizations (UFM 2018). Moreover, Denmark invests a higher share than any other OECD country in the health and medical sciences. In recent years this trend has been amplified by a significant increase in investments made in medical university research by a number of large private RFOs (Aagaard 2016; Degn 2018; UFM 2016, 2018).

These funding trends have entailed a gradual but substantial change in the balance between institutional and external funding (Aagaard 2017) where, as visualized in figure 1, the share of external funding has been steadily growing.[6]

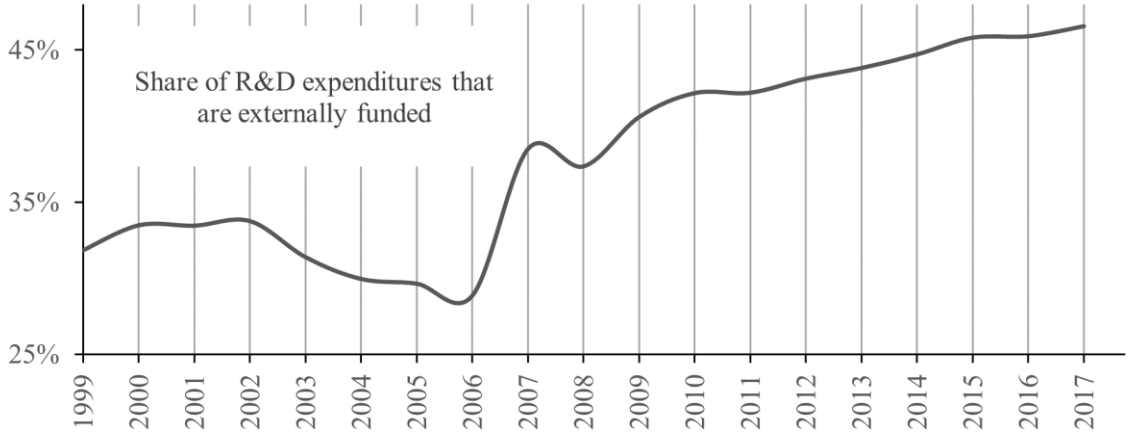

Figure 1. Share of research expenditures at Danish universities deriving from external funding sources, 1999–2017 (Source: Statistics Denmark 1999–2011 and Universities Denmark 2012–2017).

The growth in funding deriving from external sources runs parallel to a growing concentration of research funding on a limited number of scientists and topic areas. This tendency is documented in a recent analysis of the allocation patterns across 15 major Danish public and private research funders including nearly 20,000 grants and 7,539 grantees (Madsen and Aagaard 2020a). We recap key insights from this analysis in the following. At the individual level the top 20 percent most highly funded grantees in Denmark account for 75 percent of the total funding allocated. If we compare with the research population as a whole (above PhD-level), using a rather conservative benchmark of 15,000 active researchers over the analyzed period, we find that the top 20 percent amass just shy of 90 percent of the total amount of funding (see figure 2).

[6] In this paper, we distinguish between "institutional" and "external" funding. Institutional funding is state-subsidized funds allocated to all Danish universities. Institutional funding is administered by the universities and distributed locally at the faculty and departmental level, and typically covers research and research-based education in addition to recurrent expenses such as: salaries, rent, water and electricity (Uni. DK 2016, 71–75). External funding are financial resources acquired from either competitive public sources or from private sources. External funds are typically administered locally at the department hosting the grant holder.

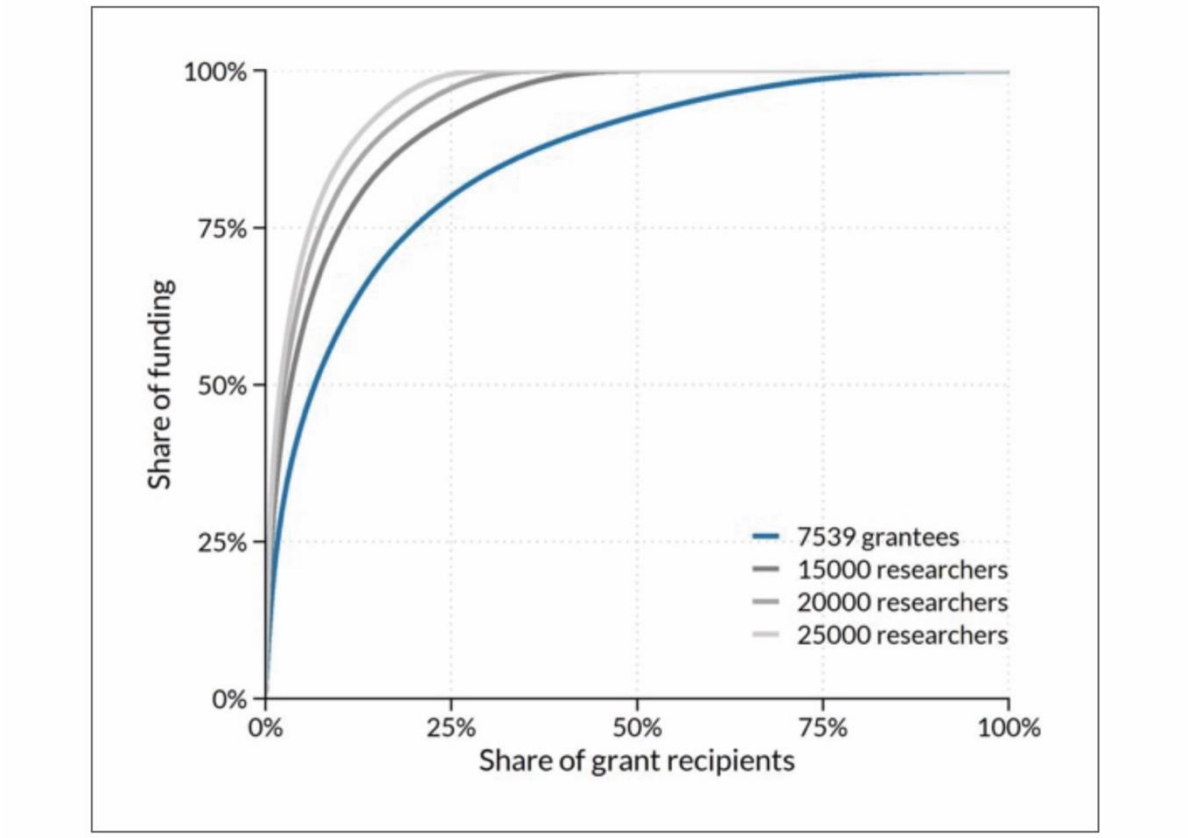

Figure 2. Cumulative share of funding for grantees and estimated population of researchers (Source: Madsen and Aagaard, 2020a).

Similarly, we find a marked concentration of funding at the level of individual research areas. Figure 3 depicts the topic distribution of 12,269 grants across major research areas (based on topics in the publications of grant recipients). Each bubble or node represents a research area based on 39 categories from the OECD Frascati manual (2015). The links illustrate the interconnectedness of the different research areas based on citation traffic. Overall, the figure shows a marked skewness of competitive funding towards the biological and medical sciences (the blue areas). Notice that biomedicine is found exactly in this border region between the biological and medical sciences.

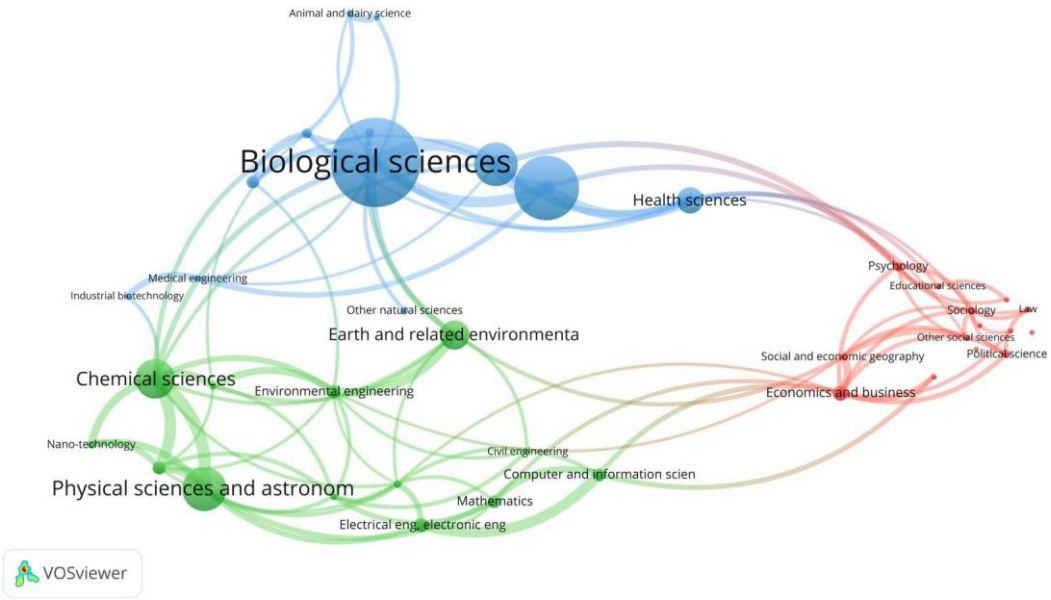

Figure 3. Funded research areas and their citation relations (Source: Madsen and Aagaard, 2020a).

In the period from 2004–2016, the biological research areas attracted a total of 6.9 billion DKK, while basic medical research and clinical research respectively received 4.6 billion and 2.8 billion. Interestingly, this pattern of funding concentration is relatively similar across public and private funders. Figure 4 shows the distribution of funding from public and private funders across the 20 top-funded OECD areas. It is worth noting that both types of funders largely prioritize similar, and rather few, areas. Again, the biological sciences and clinical medicine are the most highly funded fields. The top seven research areas[7] (see figure 4) are all located within the natural and medical sciences, and amass around 70 percent of the total funding.

[7] Biological Sciences, Clinical Medicine, Physical Sciences and Astronomy, Basic Medical research, Chemical Sciences, Earth and related Environmental Sciences, Health Sciences.

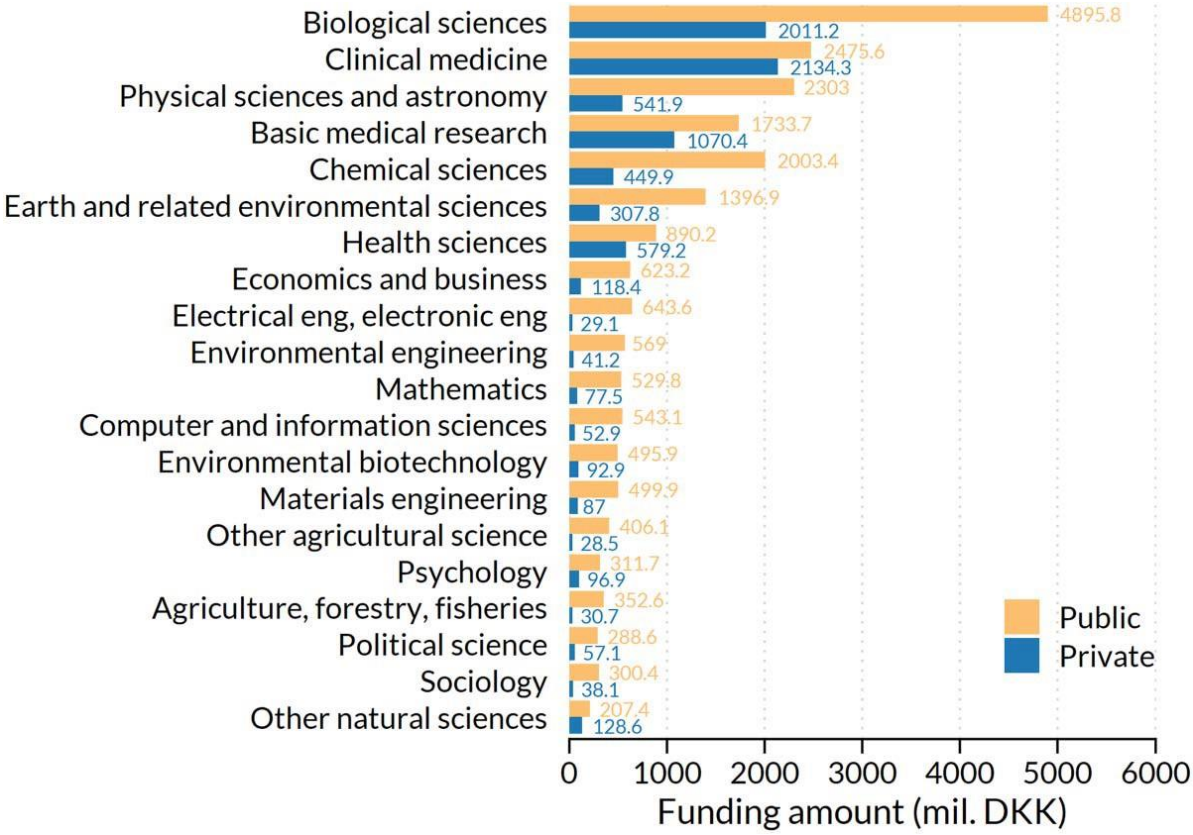

Figure 4. Public and private funding of research areas (Source: Madsen and Aagaard, 2020a).

When taking a closer look at the top-funded disease areas (see figure 5) we likewise find strong concentration on relatively few research topics. Here, we observe that diabetes in particular receives a disproportionately large share of the total funding available. In the recently conducted study, we suggest that self-sustaining positive feedback loops may be set in motion by the private foundations. Private RFOs are likely to give some researchers and topics an upper hand over others when providing additional funding within their own areas of interest (Madsen and Aagaard 2020a).

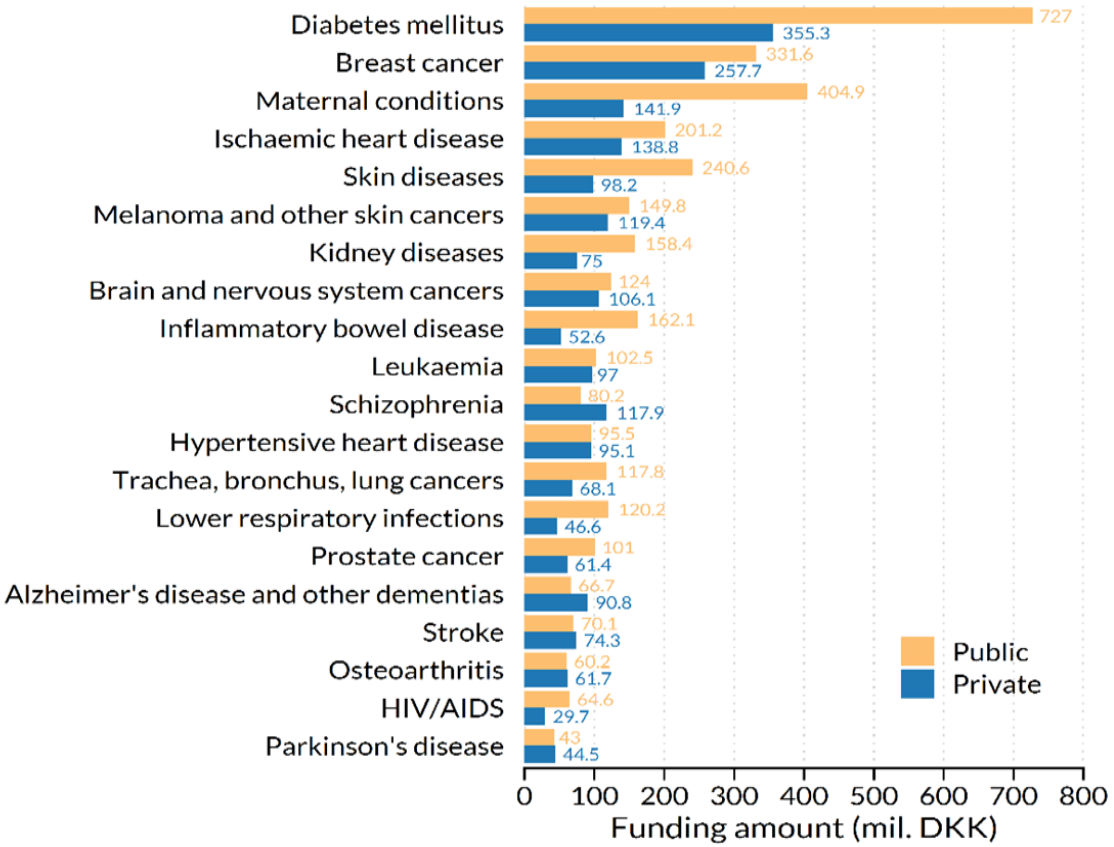

Figure 5. Public and private funding of disease specific research areas (Source: Danmarks Forsknings—og Innovationspolitiske Råd (DFIR) 2020b).

The above examination of recent developments in the funding of Danish research, highlights Denmark as a well-suited setting for exploring how researchers are affected when private research funding gains in significance. In a Danish context, this is particularly the case for the biomedical research area where substantial investments have been made by both public funders and large private foundations with close ties to the pharmaceutical industry. In the following sections we explore more in depth how these general changes in research funding are experienced at the level of individual researchers. As the researchers (that we interviewed) are at the vanguard of these changes in the Danish funding landscape, the case can be considered "extreme" rather than representative of Danish university research in general, or other international university contexts for that matter. However, it is exactly this extreme feature of our case that allows us to examine some "micro-dynamics" accompanying changes in "macro-level" funding priorities in a particularly poignant form.

Changing Research Conditions

When asked about their present funding situation, the department scientists consistently provide a narrative of decline. The institutional funding available in the past has dwindled and scientists are now more

dependent on attracting grants from external funding sources in order to cover expenses for research activities. As one of the scientists laments:

> . . .there is something peculiar about being employed at the university, having an office, a lab and receiving your salary but having to finance the activities taking place in your office and in the lab, by yourself. (department scientist)

Many of them used to be able to win public and private research grants but now experience difficulties financing their research due to austerity measures and increased competition:

> People are now slowly realizing that there is no money available. It is really difficult to attract [funding]. (department scientist)

By contrast, the scientists located at the center, right next door, experience increasing financial abundance, which provide opportunity to pursue research ideas freely. Solid and flexible center grants provided by a private foundation, cover salaries, state-of-the-art equipment, lab facilities and other recurrent expenses for research activities. This is confirmed by two group leaders from the centers:

> We have a lot of flexibility in our funding setup . . . meaning that if we get a bright idea we can go straight to the lab and try it out.

> I'm in the luxurious position of being at a center, where we have money for whatever I can think of . . . I can basically do more or less everything that I want.

Scientists at the centers report that they have been successful at winning larger research grants from a variety of private Danish RFOs, the national research council as well as EU grants:

> We have never received the amount of money that we receive now . . . this is both due to a strong research environment and because we are able to formulate research questions that we were not capable of previously. (center scientist)

What can be taken from the accounts is that informants at the centers by and large experience a relatively broad "protected space" to autonomously define and pursue research without being significantly constrained financially (cf. Luukkonen and Thomas 2016, 124; Whitley et al. 2018). By contrast, informants at the department experience a much more narrowed "negotiated space" as they are more constrained in their access to economic resources, research infrastructure and available hands to carry out experiments.

The tendency of research funders to increasingly invest in large scale excellence schemes and hand out funding through very large grants is confirmed by members of both sets of scientists. This trend, however, is experienced in different ways. As formulated by one department scientist:

> Huge center grants [are] donated by [name of private RFO]. Laureate-grants where they exempt international top scientists from teaching responsibilities, give them 60M DKK[8] and provide them with several floors [for lab facilities].

Correspondingly, the department scientists mention that the smaller grants are nowadays scarce since the big private funding bodies tend to prioritize the awarding of fewer big grants to research areas relevant to their own research focus:

> . . .earlier I think there was a will in the funding environment to keep the small research groups going . . . whereas now . . . all [the support goes to] giants . . . huge centers.

The same scientist continues:

> If you do not work within obesity, diabetes or ageing etc., it is really hard to attract funding.

In other words, scientists increasingly need to work in large research units located within prioritized areas to succeed. Only large research groups with critical mass and the necessary research support capacity are able to attract medium-sized and large grants. Accordingly, this gives the research groups at the centers a competitive advantage over scientists at the department that are either working in small research groups or alone. We thus see how the growing volume of external funding impacts on the organization of research by privileging still larger units.

The relational effect of these changes has not gone unnoticed by scientists. In the words of one of the informants,

> . . .the Matthew effect is crystal clear [at the faculty] as the rich get richer and the poor get poorer. (department scientist) (cf. Merton 1968)

Scientists at the department see the center based scientists as benefitting from a self-perpetuating process of cumulative advantage that mirrors the "credibility cycle of science" (Latour and Woolgar 1986). The center scientists themselves also recognize this dynamic:

> You . . . look at . . . the CV of the applicant . . . [T]here is something self-reinforcing about being in a good period publication-wise . . . And if you have a research group with high publication rates and impact the reviewers know that something [productive] will come out of it. (center scientist)

By comparison, the scientists interviewed at the department see themselves as winding up in a negative feedback loop, where insufficient publication lists, lead to a shortage of accumulated scientific capital that can be converted into grants and in turn reconverted into publications and peer recognition:

> If you don't make good experiments, if you don't get them published well, then you won't have a great CV, which means that you won't win any funding next time you write an application (center scientist).

[8] The equivalent of approximately €8M.

The center scientists accordingly benefit from an upward spiral funding and publication-wise whereas scientists at the department see themselves as stuck in a vicious circle when it comes to attracting vital funding for doing new experiments and for maintaining a steady research output (cf. Laudel 2006a, 398; Leisyte and Dee 2012, 151).

Scientists at the department report a gradual divergence at the faculty between scientists solely preoccupied with research and scientists primarily preoccupied with teaching:

> We increasingly need to differentiate between having pure teaching positions and pure researching positions. (department scientist)

Where the center scientists do not have any formal teaching obligations and thus can dedicate almost 100 percent of their time to research, the majority of the scientists interviewed at the department spend increasingly more time on teaching:

> In theory we have 50 percent teaching/administration and 50 percent research but . . . if a scientist is not able to raise funding for research s/he can still maintain tenure by taking up more teaching. (department scientist)

We thus observe how changing funding circumstances which are external to the scientific field appear to reconfigure the power relations within the field (the accruement of scientific and symbolic capital conferred through successful publications and citations) (cf. Bourdieu 1988). One result is that less successful scientists are forced to substitute research with less meritorious practices such as teaching activities thereby further perpetuating the erosion of scientific capital.

Coping Strategies

The success of the center scientists largely appears to be attributable to their ability to produce publications (scientific capital) faster because they have access to state-of-the-art equipment and manpower (financial capital), work in big groups and have extensive collaborations nationally and internationally (social capital) (cf. Albert and Kleinman 2011, 267; Bourdieu 1986, 281). This competitive advantage is in turn related to the location of the center scientists within strategically important research areas prioritized by some of the large funding bodies. Academic success thus seemingly depends both on the ability to maintain a steady research output and acquiring research funding:

> The last time I received funding from FNU and FSS[9] it correlated quite well with two papers we had just published in two good journals . . . you need to show that you are productive and that you publish in good journals. (center scientist)

By comparison, informants in the other set report that the current publication volume of many scientists at the department is low:

[9] Danish Council for Independent Research Natural Sciences (FNU), and Medical Sciences (FSS).

> It is very costly to get labor for doing research and the money is gone. Thus, we are not able to do as much research which means that the volume has dropped. (department scientist)

In addition, scientists from both sets agree that the ability to mobilize social and cosmopolitan capital in the form of access to research networks, international collaborations and experiences abroad are necessary preconditions for succeeding in contemporary science. While all scientists interviewed at the centers mention having extensive interaction with other research environments both within and beyond the borders of Denmark, not all the department scientists mention having frequent collaborations with fellow colleagues.

Several informants refer to the academic value and recognition attached to winning prestigious grants and scientific awards (cf. Bourdieu 1984; Rip 1994):

> [O]ften when you talk about people's success you talk about: "oh right they got the ERC grant" . . . You talk about their success in attracting funding. It's become sort of a strange world. (department scientist)

Some of the scientists even suggest that the ability to win prestigious grants now seems to have trumped publications as the primary indicator of scientific success:

> I have been told that many departments consider it more important to win a grant than to publish a paper. There is no discussion about it. (center scientist)

This suggests that the intrinsic symbolic and reputational value of winning a research grant is now worth more than the sheer monetary value of the grant itself as it translates *directly* into scientific capital (see Rip 1994 for a similar discussion). Grants themselves become capital in the scientific field, independently of whether they actually facilitate noteworthy scientific results.

Scientists from both sets perceive a need to adjust to the changing funding terrain in order to stay in the game. Because grant-winning gains in significance vis-à-vis other prestige items in science, scientists may adjust their strategies (problem choice) by pursuing more "fundable" types of research (cf. Vallas and Kleinman 2008, 293). The mantra of "publish or perish" is evidently not losing validity, but is increasingly being overlayered by "apply or die" as an irrevocable principle of survival (cf. Ziman 1994, 97). Yet, the scientists in the two sets employ widely different strategies as means to cope with their respective funding situations. Notably, center scientists attempt to do more clinically-oriented research and take their research in more "translational" directions, using research collaborations strategically as a way to improve their chances of funding success (cf. Hessels et al. 2011, 555):

> . . .we have thought about how to make our group more visible in relation to more translational research . . . And the only way we can do this is through research collaboration with hospitals and the industry. (center scientist)

Here, another center scientist along similar lines:

> I started out as very curiosity-driven, but I am now branching to the other side. I am going to focus on . . . drugs . . . that are easily sellable, relatable to cancer . . . I am switching more to see if I can push [my research] into something that is . . . commercial. Grant worthy. (center scientist)

Moreover, scientists from the centers state that some of them are now compelled to pursue more risk-averse, "safe" and short-sighted research in an effort to maintain steady research outputs and thereby increase their chances of winning further grants (cf. Laudel 2006a, 392–93):

> . . .most people will choose something that is a bit more safe. Because if you choose something that's a bit more safe then you might publish something to get a grant . . . my boss will not choose the risky one [project] because he is . . . mainly focused . . . on publications. (center scientist)

One center-based PI suggests that as a consequence of the changed funding landscape, he and his group feel increasingly compelled to do more risk-averse and short-sighted research—contrary to his cognitive interests:

> With the current time horizon in mind we are well aware that we cannot do any risky [research] . . . The research we are currently able to do is rather short-sighted . . . and for me personally that's a real shame. (center scientist)

Thus, while even well-endowed center scientists feel that their cognitive interests are distorted by funding considerations, the situation is more problematic still for the less well-endowed department scientists. They by comparison, try to stay in the game by increasingly diversifying research, expanding their portfolio of possible research topics:

> One of the consequences [of the present funding situation] is that all of us are spreading out locally and meddle in each other's projects, allowing us to expand our research portfolio. (department scientist)

As the following statement shows, another coping mechanism employed is to change the research topic to one where it is easier to receive funding:

> In recent years we [I] have been switching more between different topic areas compared to previous years where I worked on the same topic. I think this is a consequence of what is happening at the moment. You have to spread out more across the [epistemic] landscape in order to find more "hits." (department scientist)

Topic Choice Effects

When explored in more detail, the accounts from the two different research settings not only evidence the coping strategies available to researchers in different locations in the scientific field. It also suggests a range of interesting topic choice effects related to developments in the current funding regime.

Our interviewees corroborate the statistics outlined earlier, pointing out that large Danish foundations with strong ties to the pharmaceutical industry in recent years have allocated very large funds to still more specific research fields within their own priority areas:

> They [name of private RFO] have during recent years channeled their funds to specific areas that are beneficial to them. (department scientist)

These donations are now so large that they are allegedly substantially affecting the intellectual agenda of the University of Copenhagen through its recruitment strategy:

> People are recruited within the interest areas of these foundations whereas the rest are being pushed out. (department scientist)

In a similar vein, some of the scientists suggest that the private foundations have a large say in the development of the national research policy agenda in Denmark:

> I don't think the private foundations try to hide the fact that they are political players (center scientist).

> When politicians see that [name of private RFO] is donating money to a certain research area they might also be compelled to follow along in the same direction. (department scientist)

Interestingly, scientists from both sets mention that they need to frame and twist their research focus more now than what they used to in order to make it fit with the requirements of funders (cf. Andras 2011, 94; Ziman 1987, 94):

> It has probably gotten slightly more difficult [to win grants]. You probably have to twist things a bit more. (department scientist)

> [I]t quickly becomes a bit technical . . . How do you manage to phrase your ideas in the way that you see as most fitting for the different foundations you apply for. (center scientist)

> When you apply for money . . . you look at whether it's possible to frame your research in a way that is interesting to the funders. (department scientist)

These quotes largely conform with Luukkonen and Thomas' (2016) description of a "negotiated space" where researchers seek to establish a workable balance between their assessments of the opportunities to gain scientific capital through prestigious publications and cognitive autonomy on the one hand, and the interest of funding bodies to steer research in particular directions on the other hand. Some of our interviewees point out that this may have a number of unintended consequences for the broader field of medical science and education.

Scientists at the department claim that it is currently difficult to attract funding for research within the area of e.g. basic physiology:

> . . . pure physiological research where you look at basic mechanisms is not politically sexy and no money is being allocated to this area . . . Somebody has to know about the gastrointestinal tract, the kidney and the liver etc. and these areas are not particularly hot at the moment. (department scientist)

According to several of the scientists interviewed at the department, research areas such as: high blood pressure, kidney research and cellular communication have been underprioritized in recent years and do currently not receive much funding. As noted by one informant,

> metabolic research, diabetes in particular [has by comparison] experienced a large boost funding-wise during recent years. (department scientist)

The informant continues, explaining that,

> [one of the centers] has diabetes as their main research focus so this is where the big investments are being made lately . . . foundations such as [name of private RFO] used to spread out funding more widely . . . but they don't do that anymore and this has a negative impact for the scientists who do not work on metabolism. (department scientist)

As pointed out by several scientists at the department, the fact that certain popular research areas receive the majority of funding does not mean that the less profiled disease areas have ceased to be important or worthy of support (cf. Ziman 1994, 93). As expressed by one of the department scientists:

> It does not change the fact that all the other diseases still exist. For instance, a quarter of the [Danish] population still suffers from high blood pressure irrespective of whether they are obese, diabetic, etc.

Scientists located within research areas of lower prestige where funding is not easily available are (often) required to "follow the money" and emigrate to areas of higher prestige in order to stand a chance at bringing home funding and staying in the game (cf. Gieryn 1983, 101):

> I believe that my own possibilities have improved considering that [omitted] research is a more popular area among the big foundations. We do not have that many Danish medical companies developing medications for the [omitted]. Hence, the interest in heart research is not that great. (department scientist)

One of the center scientists gives a tangible example of how the current funding climate influences the content of his own and his group's research:

> If you have ten different projects with preliminary data you will choose the projects that topic-wise will have the greatest chance of making it in a given funding call . . . it might very well be that out of the ten projects you would prefer to work on project number nine because this is the most interesting project but it is very basic in nature and unrelated to brain—or cancer research.

The informant continues:

> In that sense I would say yes, they [your funding options] do influence the direction you take . . .

Two other center-based scientists also address how the difficulty of winning research grants compels scientists to pick the type of research projects that they believe will have the greatest chance of attracting funding. As one of them remarks:

> [Y]ou will make sure you pursue the kind of science that will get you the grant. [I]t is I think influencing what kind of science is done.

The fact that certain research areas are given high priority by funding bodies has allegedly resulted in the negligence of others:

> The large foundations . . . all have rather narrow focus areas that they allocate funding to . . . On the other hand, there are other types of diseases that none of the large foundations support financially. (center scientist)

> I think it's a pity that a [faculty] spanning such a wide variety of specialties chooses to focus on certain research fields and then completely disregard the rest. (department scientist)

The consequence of prioritizing certain research areas and neglecting others is that the diversity of research areas (cf. Gläser and Laudel 2016, 125) represented at the faculty will diminish:

> I believe that we are currently headed in the wrong direction if we wish to preserve the diversity of the [scientific] growth layer. (department scientist)

> We lose the [academic] breadth [of disciplines] because [the resources] are being concentrated into too few hands. (department scientist)

One department scientist warns against some specialties being lost entirely:

> . . .we do not have any [name of specialty] physiologists left because the area has no commercial potential . . . I don't understand how a medical faculty cannot afford having a [name of specialty] physiologist . . . it's a huge organ system and it's bloody important for the treatment of [name of disease] patients, [name of specialty] cancer, etc.

As these statements suggest, one negative effect of certain areas being given high priority and others neglected is that the research areas that scientists can choose to work in, may gradually narrow over time. Accordingly, this will limit the personal freedom or the "protected space" of scientists to autonomously define and pursue research topics of their own choosing (cf. Heinze et al. 2009, 616; Luukkonen and Thomas 2016, 124; Whitley et al. 2018).

Whereas all center scientists answer that they can by and large pursue the type of research that aligns with their own research interests, four out of five scientists at the department answer that they are not able to do the research that they would ideally have liked to:

> Yeah, sure . . . currently there are many experiments that we would like to set up but cannot because we simply cannot afford it. (department scientist)

> I have many ideas that I just write down on a piece of paper and put in my drawer. If I had resources I would probably pursue these ideas further. (department scientist)

The two quoted excerpts are examples of "undone science," i.e. unrealized research ideas that potentially could have resulted in novel discoveries had they been carried out (see Gläser and Laudel 2016, 151–2).

We summarize the results of our qualitative, comparative analyses of the two sets of scientists in table 2, before proceeding to the conclusion and implications of the present study.

Table 2. Summary of key findings from interview analysis

Results pertaining to...	Department scientists	Center scientists
Funding/Research conditions	• Reduction in institutional funding • Cutback in department delivery of research infrastructure • Fewer small- and medium-sized grants available for small groups and individually based scientists • Working in small groups or alone • Overburdened with teaching obligations	• Generous center grants • Availability of cutting edge labs and research facilities • More large and mega grants to big groups and centers within selected research areas • Working in large teams • Exempt from teaching
Coping strategies / Downward and upward spirals of scientific performance	• Substitution of research with teaching • Diversification of research portfolio • Halt in research activities and low publication volume (declining scientific capital) • Few or no resources for costly labor and lab experiments (declining financial capital) • Working in small groups or individually and less frequent collaborations with fellow colleagues (declining social capital)	• More clinically oriented/translational research (collaborations with hospitals and industry) • More risk-averse and applied research • Getting out publications/research results faster (growing scientific capital) • State-of-the-art equipment, lab facilities and manpower (growing financial capital) • Working in big teams and making use of extensive collaborations nationally and internationally (growing social and cosmopolitan capital)
Perceived topic choice effects	• Framing research and tailoring research proposals to funding bodies • Switching from areas of low to high prestige • Threatens diversity of research areas and breadth of disciplines • Loss of research specialties • Limitation in pursuit of research ideas	• Framing research and tailoring research proposals to funding bodies • More risk-averse research and selection of more fundable research • Funding concentration on selected research areas • Great autonomy in selection of topics and pursuit of ideas within the confines of prioritized areas

Conclusion and Implications

Private research funding is gaining in importance across many university settings (Aagaard et al. 2021). However, it is still not well understood how this may affect the organization and content of research. In this article, we build on results that document how changes in the Danish funding terrain have engendered increases in the concentration of resources on both individual scientists and within a narrow range of disease areas.

Using these results as the backdrop for an in-depth qualitative analysis, the exploratory nature of our case study allowed us to investigate local micro-level effects of rising private funding on biomedical research at a major Danish university. This is arguably an exceptional case, since private funding of public research is particularly widespread in Danish science compared to other countries in the OECD, notably

within the biomedical area, mainly due to a longstanding tradition of favorable funding legislation and tax policies (Lund and Berg 2016). We suggest however, that the Danish case may be indicative of more general trends that might gain in significance internationally as suggested above. We consider three findings particularly noteworthy:

First, our study suggests that private funding tends to further amplify hierarchical differences between researchers and research units even within the same institution and research branch. According to our interviewees, this promotes a concentration of research activity within areas of strategic interest to private donors, thus producing a less diverse research ecology. This need not be a problem for research per se (on a macro-scale) provided complementary research is conducted elsewhere. However, at the individual institution it is perceived to be a problem for the ability to deliver high quality, research-based teaching if certain research areas are abandoned and the quality of instruction is lowered as a consequence.

Second, we have observed how private funding is perceived not only to concentrate resources and research efforts but also scientific prestige in selected areas, as grant winning is reported to gain in significance as a marker of achievement. To succeed in the scientific field it is no longer seen as sufficient to be the author of high-impact publications, scientists also need to attract funding and win prestigious grants.

Third, even successful researchers stress that the requirements to continuously bring in external funding tend to push them towards less risky research. The balance between the desire to produce novel scientific discoveries and the need to secure a continuous flow of funding appears to shift in favor of the latter. In effect, the increasing dominance of private funding may potentially inhibit more radical scientific breakthroughs.

These findings raise a host of questions that must be examined and possibly corroborated through further research in other national contexts beyond the Danish case. We find three issues to be particularly salient to discuss and possibly pursue further in future empirical studies:

First, this explorative study shows how certain funding arrangements—in this case the growing presence of private research funding at one Danish university—appears to produce and amplify local hierarchies (see also Hoenig 2017). Our study indicates, however, that in a funding regime where competitive funding plays an increasingly important role, the conventional scientific currency—publications in prestigious outlets—is complemented and to some extent being over-layered by a different type of capital, the winning of (prestigious) research grants. While grants are obviously valued for the financial capital they bring to the field, our study suggests that they are also increasingly valued in themselves as indicators of scientific achievement. The presence of large private research funders may thus reconfigure the power relations within the scientific field. Conducting research in an area prioritized by foundations gain in importance for the individual researcher vis-à-vis "pure" epistemic success as measured in publications. However, some grants appear to be more prestige-generating than others even if their monetary value is similar. For instance, an ERC grant is perceived to rank above a national research council grant, which again ranks over a private foundation grant. This additional value beyond the monetary presumably has to do with how much cognitive autonomy is attached to the grant in terms of problem choice. We interpret this as an indication that scientists are inclined to strive for cognitive autonomy vis-à-vis economic interests. However, it may also in Bourdieusian terms speak to the conversion rates between different types of capital: Prestigious grants, independently of their monetary value, subsequently helps to acquire further resources

in a virtuous circle. The tendency for research grants to complement research findings as a source of scientific capital is something that needs to be examined in more detail to further our understanding of how this impinges on both the organizational and epistemic dynamic of the scientific field.

Second, while rising private funding may increase the total volume of research funding available in the system, the present study suggests it will likely lead to a concentration of research capacity in domains that are particularly relevant to private funders. An important question then pertains to the interplay between private funding and traditional public funding, either as institutional funding or competitive funding. Will privately funded activities operate as complementary to public funding or will they "pull" public resources in the same "epistemic direction?" Our findings suggest that the Matthew effect may be changing in character and increasingly operate on the basis of research funding (economic capital) in conjunction with scientific prestige (symbolic capital). In addition, successful research activities sponsored by private money tend to attract competitive public funds into the same fields that appeals to private funders. In effect, this may allow private funders to "gear" their investments rather than acting as "complementary" to public funding. Furthermore, department scientists lamented that private funding is typically low on overhead, thus not covering the full costs of research. In effect, it therefore hollows out the university's institutional funding (see also Aagaard 2011; Lund and Berg 2016, 116). The result may be that certain research domains are abandoned, not because they are not important nor produce valuable results, but due to a combination of strategic priorities of private funders and financial strains on the university. We find it important to investigate whether this is a feature particular to our case organization or whether it might also be the case in other university settings internationally.

Finally, we found that "problem choice" manifested itself differently depending on the researchers' location in the field. The department scientists had to diversify their research, engage in new types of collaborations and take on more teaching tasks to maintain their jobs. In short, they perceived a narrowing of their "protected space" and an encroachment of their cognitive autonomy due to changes in the funding logic of Danish university research. The center scientists were affected as well, though. The need for a continuous output of publications in order to look successful in the eyes of research funders made some of them more risk-averse when it came to problem choice, making it less likely they would engage in high risk/high gain research and more prone to pursue "safe" and more applied research projects. It thus seems that the simultaneous growth in private funding and the decline in recurrent institutional funding may threaten the ability and willingness of university researchers to engage in truly ground-breaking research.

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References

Aagaard, Kaare. 2011. "Kampen om Basismidlerne. Historisk institutionel analyse af basisbevillingsmodellens udvikling på universitetsområdet i Danmark." [The Struggle over Core Funding. A Historical Institutional Analysis of the Development of the Core Funding Model for Universities in Denmark]. Ph.D. Dissertation. Department of Political Science. Aarhus University. https://pure.au.dk/portal/files/41541853/Kampen_om_basismidlerne_Final.pdf.

———. 2016. "Danmark: Fald i Offentlige Forskningsinvesteringer, men Stigninger i Bevillinger fra Private Fonde." *Forskningspolitikk. Fagbladet for Forskning, Høyere Utdanning og Innovasjon* [Denmark: Decline in Public Research Investments but Rise in Private Funding. Research Policy. Periodical for Research, Higher Education and Innovation], 1: 30–31. http://fpol.no/wp-content/uploads/2016/03/Forskningspolitikk-1-2016_96-dpi.pdf.

———. 2017. "The Evolution of a National Research Funding System: Transformative Change Through Layering and Displacement." *Minerva* 55(3): 279–297. https://doi.org/10.1007/s11024-017-9317-1.

Aagaard, Kaare, Alexander Kladakis, and Mathias W. Nielsen. 2020. "Concentration or Dispersal of Research Funding?" *Quantitative Science Studies* 1(1): 117–149. https://doi.org/10.1162/qss_a_00002.

Aagaard, Kaare, Philippe Mongeon, Irene Ramos-Vielba, and Duncan A. Thomas. 2021. "Getting to the Bottom of Research Funding: Acknowledging the Complexity of Funding Dynamics." *PLOS One* 16(5): 1–25. https://doi.org/10.1371/journal.pone.0251488.

Albert, Mathieu, and Daniel L. Kleinman. 2011. "Bringing Pierre Bourdieu to Science and Technology Studies." Minerva 49(3): 263–273. https://www.jstor.org/stable/43548606.

Andras, Peter. 2011. "Research: Metrics, Quality, and Management Implications." *Research Evaluation* 20(2): 90–106. https://doi.org/10.3152/095820211X12941371876265.

Bol, Thijs, Mathijs de Vaan, and Arnout van de Rijt. 2018. "The Matthew Effect in Science Funding." *Proceedings of the National Academy of Sciences USA.* 115(19): 4887–4890. https://doi.org/10.1073/pnas.1719557115.

Bourdieu, Pierre. 1975. "The Specificity of the Scientific Field and the Social Conditions of the Progress of Reason." *Social Science Information* 14(6): 19–47. https://doi.org/10.1177/053901847501400602.

———. 1984. *Distinction: A Social Critique of the Judgement of Taste*. Cambridge, MA: Harvard University Press.

———. 1986. "The Forms of Capital." In *Handbook of Theory and Research for the Sociology of Education*, edited by John G. Richardson. New York: Greenwood Press.

———. 1988. *Homo Academicus*. Cambridge: Polity Press and Oxford: Basil Blackwell.

Bühlmann, Felix, Thomas David, and André Mach. 2013. "Cosmopolitan Capital and the Internationalization of the Field of Business Elites: Evidence from the Swiss Case." *Cultural Sociology* 7(2): 211–229. https://doi.org/10.1177/1749975512473587.

Calhoun, Craig. 2006. "The University and the Public Good." *Thesis Eleven* 84(1): 7–43. https://doi.org/10.1177/0725513606060516.

Cooper, Mark H. 2009. "Commercialization of the University and Problem Choice by Academic Biological Scientists." *Science, Technology & Human Values* 34(5): 629–653. https://doi.org/10.1177/0162243908329379.

Danmarks Forsknings—og Innovationspolitiske Råd (DFIR). Bargmann, Madsen Emil, and Kaare Aagaard. 2020. "Fordeling af Forskningsbevillinger i Danmark—Fordelingen af udvalgte konkurrenceudsatte forskningsmidler på hovedområder og discipliner, 2004-2016." [Distribution of Research Funding in Denmark—Distribution of selected competitive research grants on main areas and disciplines, 2004-2016]. Report. Accessed August 24, 2022. https://ufm.dk/publikationer/2020/filer/2020-03-fordelingafforskningsbevillinger_cfa.pdf.

Danske Universiteter. [Universities Denmark]. 2012-2017. Universiteternes Statistiske Beredskab [Statistical Reserve for Universities in Denmark]. Statistics. Accessed February 4, 2019. Det Statistiske Beredskab—Danske Universiteter (dkuni.dk). https://dkuni.dk/wp-content/uploads/2017/12/du_tal_om_danske_universiteter_2016.pdf.

———. 2016. Tal om de danske universiteter [Key Statistics on Danish Universities]. København. Report. Accessed February 4, 2019. https://dkuni.dk/wp-content/uploads/2017/12/du_tal_om_danske_universiteter_2016.pdf.

Degn, Lise. 2018. "På Vej mod et nyt Dansk Finansieringslandskab?" *Forskningspolitikk. Fagbladet for forskning, høyere utdanning og innovasjon* [Towards a New Danish Funding Terrain. Research Policy. Periodical for Research, Higher Education and Innovation] 4: 2–23. https://pure.au.dk/portal/files/145265613/Forskningspolitikk_4_2018.pdf.

Directorate-General for Research and Innovation (European Commission), TNS Qual+, Karamat Ali, Danique, Theo Schuyt, et al. 2015. "EUFORI study: European Foundations for Research and Innovation: Synthesis Report." European Commission. https://op.europa.eu/en/publication-detail/-/publication/4f71c714-04ca-4f29-ac95-1c156c1227cb.

Franssen, Thomas, Wout Scholten, Laurens K. Hessels, and Sarah de Rijcke. 2018. "The Drawbacks of Project Funding for Epistemic Innovation: Comparing Institutional Affordances and Constraints of Different Types of Research Funding." *Minerva* 56(1): 11–33. https://doi.org/10.1007/s11024-017-9338-9.

Gieryn, Thomas F. 1978. "Problem Retention and Problem Change in Science." *Sociological Inquiry* 48(3–4): 96–115. https://doi.org/10.1111/j.1475-682X.1978.tb00820.x.

———. 1983. "Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists." *American Sociological Review* 48(6): 781–795. https://doi.org/10.2307/2095325.

Gläser, Jochen, and Grit Laudel. 2016. "Governing Science: How Science Policy Shapes Research Content." *European Journal of Sociology* 57(1): 117–168. https://doi.org/10.1017/S0003975616000047.

Gläser, Jochen, and Kathia S. Velarde. 2018. "Changing Funding Arrangements and the Production of Scientific Knowledge: Introduction to the Special Issue." *Minerva* 56: 1–10. https://doi.org/10.1007/s11024-018-9344-6.

Heinze, Thomas. 2008. "How to Sponsor Ground-Breaking Research: A Comparison of Funding Schemes." *Science and Public Policy* 35(5): 302–318. https://doi.org/10.3152/030234208X317151.

Heinze, Thomas, Philip Shapira, Juan D. Rogers, and Jacqueline M. Senker. 2009. "Organizational and Institutional Influences on Creativity in Scientific Research." *Research Policy* 38(4): 610–623. https://doi.org/10.1016/j.respol.2009.01.014.

Hellström, Tomas, and Christina Hellström. 2020. "Cross-Sectoral Mobility Funding and the Challenge of Immersion: The Case of SSH"' *Minerva* 58: 389–407. https://doi.org/10.1007/s11024-020-09398-2.

Hessels, Laurens K., John Grin, Ruud E. H. M. Smits, Harro Matt, et al. 2011. "The Effects of a Changing Institutional Environment on Academic Research Practices: Three Cases from Agricultural Science." *Science and Public Policy* 38(7): 555–568. https://doi.org/10.3152/030234211X12960315267976.

Hicks, Diana, and J. Sylvan Katz. 2011. "Equity and Excellence in Research Funding." *Minerva* 49(2): 137–151. https://doi.org/10.1007/s11024-011-9170-6.

Hoenig, Barbara. 2017. *Europe's New Scientific Elite: Social Mechanisms of Science in the European Research Area*. London: Routledge.

Hove, Kjetil H. 2020. "Does the Type of Funding Influence Research Results—and Do Researchers Influence Funders?" *Prometheus* 36(2): 153–172. https://doi.org/10.13169/prometheus.36.2.0153.

Kundu, Oishee, and Nicholas E. Matthews. 2019. "The Role of Charitable Funding in University Research." *Science and Public Policy* 46(4): 611–619. https://doi.org/10.1093/scipol/scz014.

Latour, Bruno, and Steve Woolgar. 1986. *Laboratory Life: the Construction of Scientific Facts*. Second Edition. Princeton, NJ: Princeton University Press.

Laudel, Grit. 2006a. "The Art of Getting Funded: How Scientists Adapt to Their Funding Conditions." *Science and Public* Policy 33(7): 489–504. https://doi.org/10.3152/147154306781778777.

———. 2006b. "The 'Quality Myth': Promoting and Hindering Conditions for Acquiring Research Funds." *Higher Education* 52(3): 375–403. https://doi.org/10.1007/s10734-004-6414-5.

Laudel, Grit, and Jochen Gläser. 2007. "Interviewing Scientists." *Science, Technology & Innovation Studies* 3(2): 91-111. http://dx.doi.org/10.17877/DE290R-983.

——. 2014. "Beyond Breakthrough Research: Epistemic Properties of Research and Their Consequences for Research Funding." *Research Policy* 43(7): 1204–1216. https://doi.org/10.1016/j.respol.2014.02.006.

Leisyte, Liudvika. 2007. "University Governance and Academic Research: Case Studies of Research Units in Dutch and English Universities." PhD Dissertation. Faculty of Behavioural, Management and Social Sciences. University of Twente. Accessed February 4, 2019. http://doc.utwente.nl/58088.

Leisyte, Liudvika, and Jay R. Dee. 2012. "Understanding Academic Work in a Changing Institutional Environment. Faculty Autonomy, Productivity and Identity in Europe and the United States." In *Higher Education: Handbook of Theory and Research*, edited by John C. Smart, and Michael B. Paulsen. Volume 27. Dordrecht: Springer. https://doi.org/10.1007/978-94-007-2950-6_3.

Lepori, Benedetto, Peter van den Besselaar, Michael Dinges, Barend van der Meulen, et al. 2007. "Indicators for Comparative Analysis of Public Project Funding: Concepts, Implementation and Evaluation." *Research Evaluation* 16(4): 243–255. https://doi.org/10.3152/095820207X260252.

Lund, Anker B., and Christian E. Berg. 2016. Dansk fondshistorie. [History of Danish Foundations]. Copenhagen: Djøf Forlag. https://research.cbs.dk/en/publications/dansk-fondshistorie.

Luukkonen, Terttu, and Duncan A. Thomas. 2016. "The 'Negotiated Space' of University Researchers' Pursuit of a Research Agenda." *Minerva* 54(1): 99–127. https://doi.org/10.1007/s11024-016-9291-z.

Madsen, Emil B., Kaare Aagaard. 2020a. "Concentration of Danish Research Funding on Individual Researchers and Research Topics: Patterns and Potential Drivers." *Quantitative Science Studies* 1(3): 1159–1181. https://doi.org/10.1162/qss_a_00077.

——. 2020b. "Fordeling af Forskningsbevillinger i Danmark—Fordelingen af Udvalgte Konkurrenceudsatte Forskningsmidler på Hovedområder og Discipliner, 2004-2016." [Distribution of Research Funding in Denmark—Distribution of Selected Competitive Research Grants on Main Areas and Disciplines, 2004-2016]. *Danmarks Forsknings—og Innovationspolitiske Råd (DFIR)*. Report. Accessed August 24, 2022. https://ufm.dk/publikationer/2020/filer/2020-03-fordelingafforskningsbevillinger_cfa.pdf.

McGuire, Wendy. 2016. "Cross-Field Effects of Science Policy on the Biosciences: Using Bourdieu's Relational Methodology to Understand Change." *Minerva* 54(3): 325–351. https://doi.org/10.1007/s11024-016-9300-2.

Merton, Robert K. 1968. "The Matthew Effect in Science: The Reward and Communication Systems of Science are Considered." *Science* 159(3810): 56–63. https://doi.org/10.1126/science.159.3810.56.

Morris, Norma. 2003. "Academic Researchers as 'Agents' of Science Policy." *Science and Public Policy* 30(5): 359–370. https://doi.org/10.3152/147154303781780326.

Morris, Norma, and Arie Rip. 2006. "Scientists' Coping Strategies in an Evolving Research System: The Case of Life Scientists in the UK." *Science and Public Policy* 33(4): 253–263. https://doi.org/10.3152/147154306781778957.

Mulkay, Michael J., and David O. Edge. 1973. "Cognitive, Technical and Social Factors in the Growth of Radio Astronomy." *Social Science Information* 12(6): 25–61. https://doi.org/10.1177/053901847301200602.

OECD—Organisation for Economic Co-operation and Development. 2015. "Frascati Manual." *Guidelines for Collecting and Reporting Data on Research and Experimental Development*. Accessed August 14, 2022. https://doi.org/10.1787/9789264239012-en.

———. 2019. "Gross Domestic Spending on Research and Development (R&D)." Indicator document. Accessed February 4, 2019. https://doi.org/10.1787/d8b068b4-en.

Rip, Arie. 1994. "The Republic of Science in the 1990s." *Higher Education* 28(1): 3–23. https://www.jstor.org/stable/3447860.

Sarewitz, Daniel. 2016. "Saving Science." *The New Atlantis* 49: 4–40. http://www.jstor.org/stable/43893401.

Slaughter, Sheila, and Gary Rhoades. 2004. *Academic Capitalism and the New Economy: Markets, State, and Higher Education*. Baltimore: Johns Hopkins University Press.

Statistics Denmark. 1911–2011. "Research and Development." Online Statistics. Searched for 2011–2017. Accessed February 4, 2019. Statistics Denmark Website. https://www.dst.dk/en/Statistik/emner/uddannelse-og-forskning/forskning-udvikling-og-innovation/forskning-og-udvikling#.

Uddannelses-og Forskningsministeriet. 2016. Private Fonde. En kortlægning af bidraget til dansk forskning, innovation og videregående uddannelse. København. [Private Foundations – A Mapping of the Contribution to Danish Research, Innovation and Higher Education]. Report. Accessed February 4, 2019. https://ufm.dk/publikationer/2016/private-fonde-en-kortlaegning-af-bidraget-til-dansk-forskning-innovation-og-videregaende-uddannelse.

———. 2018. Forskningsbarometer [Research Barometer]. København. Report. Accessed February 4, 2019. https://ufm.dk/publikationer/2018/forskningsbarometer-2018.

Vallas, Steven P., and Daniel L. Kleinman. 2008. "Contradiction, Convergence and the Knowledge Economy: The Confluence of Academic and Commercial Biotechnology." *Socio-Economic Review* 6(2): 283–311. https://doi.org/10.1093/ser/mwl035.

Wang, Jian, You-Na Lee, and John P. Walsh. 2018. "Funding Model and Creativity in Science: Competitive versus Block Funding and Status Contingency Effects." *Research Policy* 47(6): 1070–1083. https://doi.org/10.1016/j.respol.2018.03.014.

Whitley, Richard, Jochen Gläser, and Grit Laudel. 2018. "The Impact of Changing Funding and Authority Relationships on Scientific Innovations." *Minerva* 56(1): 109–134. https://doi.org/10.1007/s11024-018-9343-7.

Ziman, John M. 1981. "What Are the Options? Social Determinants of Personal Research Plants." *Minerva* 19: 1–42. https://doi.org/10.1007/BF02192547.

———. 1987. "The Problem of 'Problem Choice.'" *Minerva* 25(1/2): 92–106. https://www.jstor.org/stable/41820679.

———. 1994. *Prometheus Bound: Science in a Dynamic Steady State*. Cambridge: Cambridge University Press.

Zuckerman, Harriet. 1978. "Theory Choice and Problem Choice in Science." *Sociological Inquiry* 48(3–4): 65–95. https://doi.org/10.1111/j.1475-682X.1978.tb00819.x.