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The evolution of a national research funding system

Radical transformation through layering and displacement

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Abstract: *This article outlines the evolution of a national research funding system over a timespan of more than 40 years and analyses the development from a rather stable Humboldt inspired floor funding model to a complex multi-tiered system in constant flux. Based on recent contributions to Historical Institutionalism it is shown how the system has changed gradually along a number of dimensions through layering- and displacement processes and how the sum of mainly minor adjustments over time has led to a radical transformation of the funding system as a whole. It is also shown that the traditional academically oriented research council system has been remarkable resilient against far-reaching restructuring attempts. This change resistance has, however, on several occasions led the political system to implement change through other funding channels which for prolonged periods of time has made the councils somewhat marginalized.*

1. Introduction

Denmark currently stands out as one of the highest performing research nations of the world measured in mean normalized citation scores (Aagaard & Schneider, forthcoming). The background of this position is however underexplored. This article analyses the evolution of the public Danish research funding system in a long term perspective based on the notion that the funding system constitutes a central policy instrument for decision makers and works as the single most important element in defining the scope, content and direction of public research systems (Edquist 2003). Along the same lines it is argued that funding is one of the main channels by which authority is exercised over research, and that funding changes therefore can be expected to have significant effects on the production of scientific knowledge (Whitley, Gläser and Engwall 2010). A detailed understanding of its evolution and composition is therefore vital.

While we have evidence of some general lines of development in the evolution of national research funding systems and while a more detailed assessment has been made in a few countries (Lepori 2006, Braun et al. 2003, Larédo and Mustar 2001), it is still uncertain how accurate these aggregated international trends are mirrored in most individual countries (Geuna and Martin 2003; Auranen and Nieminen 2010). An important limitation with regard to cross country comparisons of funding patterns concerns the data quality of the time-series in the OECD MSTI (Main Science and Technology Indicators) databases which go back to 1981. The database suffers from breaks in the series and lack of unification across countries. There are in other words differences among countries in data collection methods and in the use of definitions from the Frascati Manual (Godin 2005, Lepori 2006, Crespi and Geuna 2008). The limitations of these data furthermore include problems in the measure of the share of research in higher education expenditure and a lack of categories needed for policy analysis. These lacks are not least prominent concerning funding agencies, instruments and scientific disciplines (Irvine et al. 1990, Godin 2005). As a consequence, evidence is often anecdotal: there are for example limited data on the share of project funding in different countries, since this category is non-existing in most R&D statistics. Likewise, there are few quantitative studies on shifts in the portfolio of instruments. Furthermore, great uncertainty is linked to the questions of when, how and how fast these changes have occurred in different countries. While some analysts highlight decisive turning points between different phases or paradigms (see e.g. Elzinga and Jamieson 1995, Guston 2000), other studies suggest that public funding has evolved through the addition of new instruments that parallel the existing ones, rather than through their replacement (Lepori et al. 2007). A main theoretical and empirical question is then whether the pattern is dominated by incremental, evolutionary changes rather than discontinuity and dramatic breaks (Benner and Sandström 2000, Streeck & Thelen 2005, Lepori 2006).

A thorough analysis of the combined long-term development in research policy and research funding can now be examined in a Danish context due to newly created time-series of public research funding covering more than four decades. The available quantitative data are to a large extent without the limitations of the OECD time-series and are also covering a substantially longer time span. In addition, the Danish system has since 1982 had a clear separation between funding for research and funding of education activities allowing for a more precise estimation of research expenditures. In the analysis the funding data are supplemented with other quantitative sources as well as detailed qualitative data of changes in research policy within the same period. Aagaard (2011) supplies a comprehensive account of the Danish research policy development in the period from 1968 to 2010 based on document analysis and interviews with a number of central research policy actors. This material enriches the interpretation of the time-series and hereby contributes to the emerging mapping of long-term funding changes across countries (Lepori 2006). The article has two main research questions:

- 1) How has the Danish research funding system developed in the period from 1968 to 2011 with regard to overall volume, the balance between floor funding and external funding, the composition of the external funding, and the division of funding between universities and other public research institutions?

- 2) How can the change processes be characterized? Can we identify decisive turning points or have the processes been more gradual? What do these patterns of change reveal with regard to the outcome of different reform strategies?

The article proceeds as follows: Section 2 presents the theoretical framework applied in the analysis, while section 3 gives a brief review of the literature and outlines a number of important international research funding trends. Section 4 contains the actual analysis of the Danish development. Section 5 contains our discussion and conclusion.

2. Transformative change as the result of gradual evolution

To explore the development of the Danish research funding system this article takes recent contributions to historical institutionalism as its point of departure. However, the approach taken here challenges central premises of historical institutionalism in its traditional form as it seeks to go beyond the previously dominating punctuated equilibrium/revolutionary change logic of historically-based path dependence. Traditional historical institutionalism has good theories of why institutional configurations come into being in certain cases, and it has good theories to explain the events where these institutional configurations are replaced with new ones (Mahoney & Thelen 2010). Still lacking, however, were until recently equally useful tools for explaining the more gradual evolution of institutions. This shortcoming has led to a convincing and theoretically innovative contribution to the understanding of evolutionary change. This perspective goes beyond the logic of positive reinforcement and increasing returns to address the question of how institutions continue to evolve and change over time (Thelen 2003). The argument is, that institutional change takes multiple forms, and that strategies for institutional change systematically differ according to the character of the institutions and the political settings in which they are situated (Hacker 2004: 244). Different forms of evolutionary, but nonetheless transformative, institutional change have accordingly been suggested resulting in an empirically based typology with four main categories, (Mahoney & Thelen 2010, Streeck & Thelen 2005, Hacker 2004, Thelen 2003). The four types of change which gives important insights into the mechanisms behind political evolution and continuity are: *layering*, *displacement*, *drift*, and *conversion*.

The main focus in the remainder of this article will be on the two former of these: *layering* and *displacement*. *Layering* covers a process in which new institutional elements are added to already existing ones (Schickler 2001, Thelen 2003, Mahoney & Thelen 2010: 21). In contrast to more radical changes *layering* do not initially include entirely new sets of institutions, but rather take the form of additions to existing systems. The concept thus emphasizes the partial renegotiation of elements of a given set of institutions, while others are maintained (Thelen 2003: 20). A main point is however, that what is at first introduced as relatively marginal correctives or as fine-tuning of existing institutions over time can lead to substantial change, when a number of marginal additions add up, or when – as described below – new elements grow at a faster pace than the old ones. Changes introduced in this way do not from the outset undermine the existing institutions and does therefore not necessarily lead to counter-mobilization.

The second variant, *displacement*, covers a process in which the balance between various elements of the existing institutions changes. According to this perspective institutional systems are never entirely consistent. Although some elements dominate, they typically exist alongside other elements created at other times and under different historical circumstances. When this is the case, institutional systems become vulnerable to change through shifts, because dominant logics may be discredited or displaced in favour of others (Streeck & Thelen 2005: 20). Examples could be revitalization and upgrading of formerly oppressed solutions or just the prioritization of newly added features at the expense of existing ones. *Displacement* is accordingly not an explicit review of existing institutions, but rather shifts in the relative importance of various elements which over time can lead to significant institutional change (Streeck & Thelen 2005). A central mechanism is here differentiated growth where new elements are growing faster than traditional ones, and thus gradually alter the institutional balance (Streeck & Thelen 2005: 23). When actors interested in change can't succeed with a frontal attack on existing institutions differential growth of selected elements can instead lead to the desired changes. The approach as a whole thus shows how actors of change have the possibility of initiating institutional transformations without confronting change resistant structures head on (Streeck & Thelen 2005: 19). The overall approach thus indicates that different change strategies can be put to use by decision makers when changes are pursued. It may on the one hand be attempted to reform the existing structures by sudden and radical change, where existing institutions either are closed down or changed dramatically. On the other hand, there is however also the possibility of implementing more gradual change through *layering* and *displacement* processes which over time can lead to equally important transformations.

The question in the remainder of this article is how the development of national research funding systems in general and the Danish system in particular has developed and how this development can be characterized seen through this theoretical lens. First we look at a number of general trends in an international perspective, and secondly we carry out a more detailed analysis of the Danish development.

3. International research funding trends

With regard to the design of national research funding systems a number of analysts emphasize the early 1980s as a decisive research policy turning point. The argument is - in very brief - that research policy decisions were fairly simple up until the 1980s; at least the ones concerning funding of academic research. The dominating research policy model in continental Europe prescribed governments to provide general institutional funding (floor funding) for both research and teaching, leaving the research institutions free to determine the allocation of resources (Martin 2003: 8), or to channel (some of) the research funding through academically oriented research councils (Rip 1994). The policy objectives found their rationale in both the Humboldtian university-model and the linear 'science push' model of innovation (Bush 1945). The implication of the linear model was that if governments allocated money to basic research, societal benefits would eventually, but unpredictably, materialize (Cohen, Nelson and Walsh 2002). The model implied, just like the Humboldtian ideals, that few strings should be attached to the public funds provided to universities,

leaving them with considerable autonomy (Sörlin 2007). Several authors have described this model as the 'old social contract for science' (Van der Meulen 1998, Guston 2000, Martin 2003).

However, according to this literature a break with the underlying rationales of this traditional research policy model started to occur during the 1980s. While the social contract based on the linear "science push" model provided basic researchers with great autonomy, the new social contract implied that scientists in return for public funds should be accountable and explicitly address research problems of industrial and social relevance (Gulbrandsen & Smeby 2005). The emerging underlying view was not only that our societies are turning into knowledge-societies functioning in a global knowledge- and innovation-economy (Etzkowitz, 1999, Nonaka & Takeuchi 1995), where production of knowledge and knowledge servicing are becoming the most important wealth creating activities (Böhme & Stehr, 1986; Stehr, 1994; Drucker, 1994), but also that the linear model was too simple as a foundation for funding decisions (Kline & Rosenberg, 1986). Instead, public research institutions in general and universities in particular started to be perceived as key organisations that should contribute to national wealth creation by linking their work closely to the needs of the economy and society (Martin 2003, Gibbons et al 1994, Etzkowitz & Leydesdorff 1997, Lundvall 1992). Through changed funding regimes policy-makers accordingly started to aim for a close "triple helix" relationship between universities, governments and industry (Etzkowitz and Leydesdorff 2000, Gulbrandsen & Smeby 2005).

This transformation complicated public research funding decisions considerably. The old academically oriented funding model was discredited and (partly) left behind, but no clear alternative emerged. A main reason is that the implications of the now dominant interactive model of innovation are unclear with regard to the funding of public research. On the one hand it is argued from a human capital perspective, that a large share of basic funds for the universities still are crucial to secure strong research based educations. The rationale is that the production of candidates and ph.d's remains the most important input to the innovation process in most areas (Pavitt 2001). In this and other respects the public research and higher education institutions are seen to constitute a vital infrastructure for the private research laboratories where many of the innovative activities are carried out (Freeman 1987, Lundvall 1992, Nelson 1993). On the other hand it is argued that the growing global competition demands strong prioritizations of national strength positions and concentration of resources in large units and centres of excellence. In particular the last argument has fitted perfectly with widespread New Public Management ideas which prescribe the introduction of competitive funding instruments, extended use of performance criteria, continuous management strengthenings and ever growing use of evaluations and market mechanisms to hold institutions accountable and to create incentives for efficiency and quality (Hood 1995). However, no country has chosen to exclusively favour either; there is always some sort of combination where decision-makers attempt to balance the human capital model and the more selective technology oriented model (Sörlin 2007).

In spite of the uncertainty in terms of how to allocate public research funding in the best possible way, the funding system as a whole has come to be seen as the main tool for the implementation of research policy. The level of funds available and the criteria adopted for their allocation are

accordingly viewed as being closely linked to policy objectives. Changes over time in the overall evolution of research policy models can therefore be expected to correlate with funding decisions (Braun 2003, Guston 2000). Funding, in other words, mirrors salient features of policy and reveals, in empirical terms, the ambitions that governments have with higher education and research (Sörlin, 2007). Based on these developments the literature on the subject has identified some general trends. These include: A levelling-off of funding from the 1970s and onwards after a period of rapid increases in the period following World War II (Lepori 2006). Ziman (1994) described this as a transition to a “steady state” in the funding of research. Most recently, a number of countries have even experienced severe budget cuts in the wake of the financial crisis.

While the public research funding in most (European) countries traditionally was allocated as floor funding, a shift towards external project based funding started to occur during the 1970s. A part of this development was also a shift from academic programs to programs oriented towards policy needs and economic innovation aiming to solve political problems or to promote technological development (Braun et al, 2003; Geuna, 2001). According to the literature the development towards external demands was dominant during the 1970s and 1980s while the 1990s have been characterized by greater stability or, even, by an increase in the share of academic instruments (Lepori et al. 2007, Lepori 2006). Yet another element in this development has been a steady increase in the number of project funding instruments. Lepori et al. (2007) show for a number of countries that while in 1970 there were only two to three instruments covering more than 5% of the total funding volume, in 2002 this number was eight to nine in most countries. However, also the allocation of the remaining floor funding has been the target of changes. Here we have witnessed a shift from floor funding allocated on the basis of historical criteria towards more performance based mechanisms in a number of countries (Geuna 2001, Geuna and Martin 2003, Hicks 2012). Finally, a number of countries have also observed a shift in the balance between Government Research Institutes (GRIs) and universities. Both qualitative evidence from comparative studies and quantitative data show large differences among countries in the organization of public research systems and also show evidence of changes over time within countries (Senker et al. 1999, Potì and Reale 2005). Changes in this organization are likely to affect the nature of the research as universities tend to be more academically oriented and GRIs more mission-oriented and therefore less driven by the institutional imperative to publish (Merton 1942). Where some authors suggested that universities were losing ground (Gibbons et al. 1994), it now appears as if they are becoming more central in most countries; even in countries where their role was limited in the past (Larédo and Mustar 2001, Lepori 2006).

It is, however, acknowledged that there are large country-specific differences in these public funding patterns and that it is uncertain when, to what extent and how the changes have taken place in different countries. Although the question of the type of change rarely is addressed explicitly in the literature, most accounts point in the direction of gradual changes which over time add up to major transformations. As for instance Sörlin notes: *“In this respect there is no single year or event that marks the transition from a trust-based to a performance-based funding regime. It is rather a transition that has evolved gradually since the early 1980s and is still continuing and spreading”*

(Sörlin 2007). In the following section we will examine to what extent the Danish development has followed these international trends and how the changes have taken place.

4. From a traditional floor funding model to a complex multi-tiered system

The following section analyses the Danish research funding development over a 40 year timespan. First the overall development in total funding is shown, including the developments in the division of total funding between universities and other types of public research institutions and between the main scientific areas, respectively. Secondly a more detailed analysis of the development in the balance between core funding and external funding is presented. This part of the analysis not only shows the overall changes in balances, but also the shifts in the composition of the external funding. Furthermore, the section highlights the character of both changes and non-changes in the ongoing attempts to restructure the overall funding system.

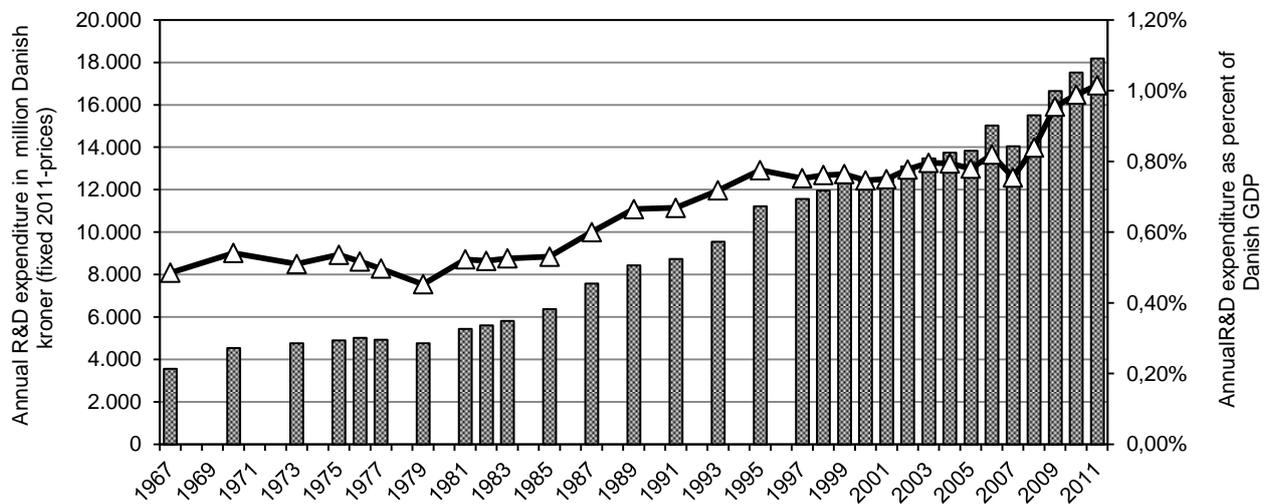
Background

It is generally acknowledged that the institutionalization of a distinct Danish research policy was quite late compared to other western countries (Aagaard 2000, 2011). R&D investments were modest and there was almost no formal organization at a central level. The funding system for Danish universities was from the post-WW2 years to the late 1970's almost totally dominated by floor funds which initially were distributed equally between research and teaching assignments based on student numbers. However, with the ever-growing student uptake accelerating during the 1960s, the political system became increasingly concerned with the fact that the research priorities primarily were side-effects of education-policy decisions (Foss Hansen 1996: 18-19; Olesen Larsen 1981). This led to a political demand for a more selective distribution of public funds for the research system and resulted in the establishment of the research council system in 1968 (Grønbæk 2001). The council system was initially perceived as a compromise between on the one hand, the university's desire to preserve the independence from the state and on the other hand the desire of the politicians to influence the direction of university research (Jensen 1996: 32). As it turned out the research council system did not develop into the steering instrument that the political system had wished for, as it operated strictly along the traditional disciplinary lines, was closely linked to the universities and focused on internal scientific criteria in a predominantly responsive allocation of funds. As a consequence the research councils were not favoured with particularly large funds in the first years (Olesen Larsen 1981: 171). Their (relatively marginal) role in the Danish research system in this period has been characterized as a classic example of self-governance (Foss Hansen 1996: 21).

Steady growth of funding

The first time-series presented in figure 1 below shows the development in total Danish public R&D expenditures throughout the period from 1967 to 2011. It is shown in fixed prices in Danish Kroner (DKK, 1 DKK equals 0.13 Euro). As seen, the overall development has been characterized by a fairly steady and almost uninterrupted growth. Two periods, however stand out with somewhat higher growth rates: the late 1980s/early 1990s and the period from 2007 to 2011. Similarly, a small drop can be observed in the late 1970s.

Figure 1 Long-term development in total Danish public R&D expenditures from 1967 to 2011 in fixed 2011 prices (Danish kroner) and as a share of the Danish GDP

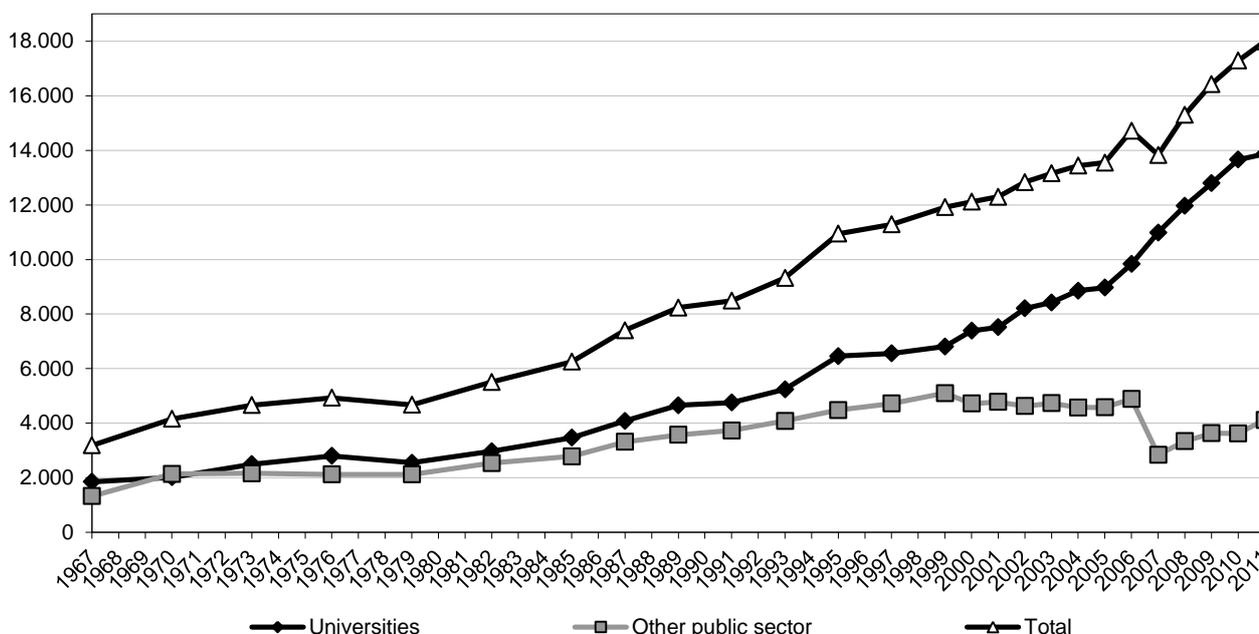


Source: Lauridsen & Graversen (2013).

Thus, we do see signs of a levelling-off of research funding during the 1970s mirroring the international trends, but the following period can by no means be characterized as a steady state. On the contrary, we see large increases during the 1990s and even stronger growth rates from 2007 to 2011. The latter period of growth was the result of the comprehensive Danish Globalisation Strategy which had as a main goal to reach the objective of the Barcelona Declaration of allocating 1 percent of GDP to public research (Danish Government 2006). However, beneath this more or less continuous growth we find a number of interesting patterns in the division of the funding. The first pattern concerns the division of funding between the universities and other public research institutions, mainly Government Research Institutions (GRIs). The Danish public research system has traditionally been characterized by a fairly sharp functional division of labour between the academic oriented universities on the one side and the more mission oriented GRI sector on the other (Christiansen and Sidenius 1988, Aagaard 2011). As figure 2 shows, the two sectors were almost equally sized and followed a very similar growth pattern up until the early 1990s. However, from 1993 and onwards a significant shift towards the university sector starts to be visible. This development can be characterized as a gradual displacement for the first decade with a differential growth in favour of the universities, but the development was then further strengthened with a comprehensive merger reform taking place in 2007. With this reform the Government reduced the number of universities from twelve to eight and transferred 12 out of 15 GRIs to one of the eight remaining universities - in reality closing down the majority of the independent GRI sector (Aagaard, Hansen and Rasmussen, forthcoming). The result was a large concentration of research resources within a few select institutions (the three largest universities now accounting for close to 2/3 of all Danish public research), and also a clear break with the former division of labour between the academic research and the more applied GRI research (Aagaard 2011). Thus, the development

both displays strong gradual elements up until 2006 and then a sudden and drastic turning point with the merger process of 2007.

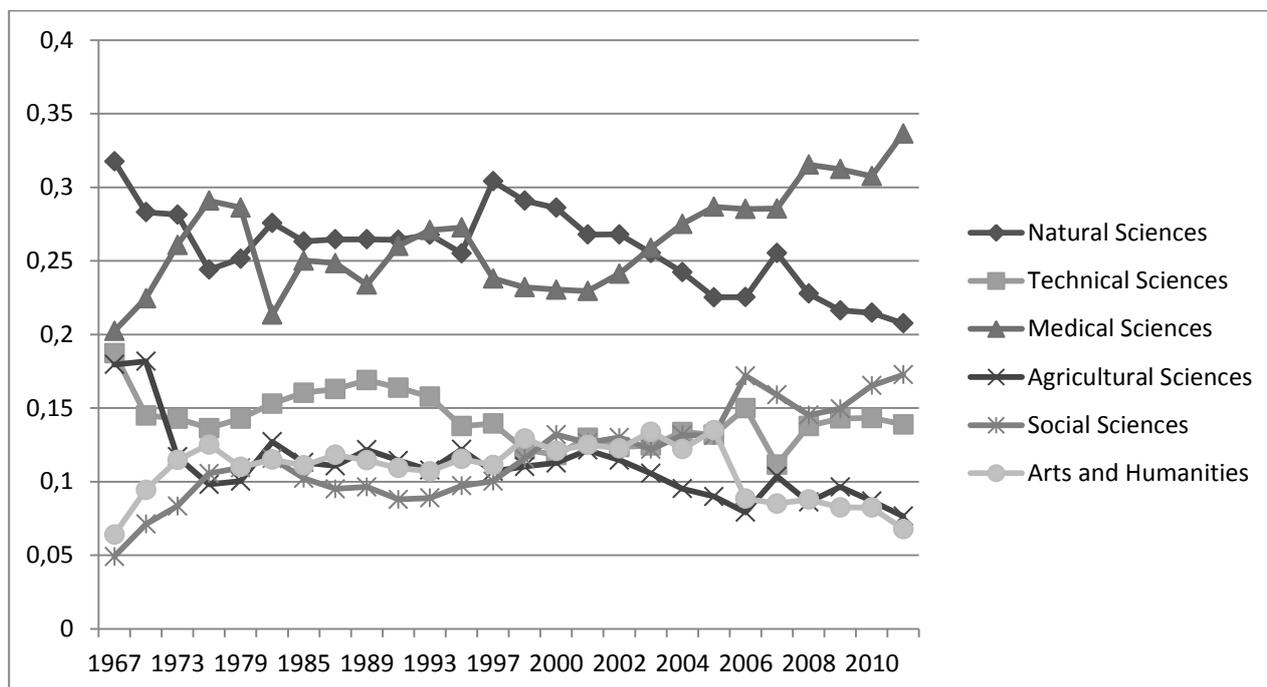
Figure 2 Long-term development in R&D expenditures in the Danish public sector according to types of research institutions: Universities, other public sector research institutions (GRI), and total public R&D expenditure. R&D expenditures are in million Danish kroner, fixed 2011 prices



Source: Lauridsen & Graversen (2013).

Similarly, in figure 3 we see some interesting shifts in the balances in the distribution of research funding between the different main scientific areas throughout the period as a whole. Two developments should be mentioned here: First, it is noticeable that the Humanities, Social Sciences and the Medical Sciences experienced a strong growth in public research funding throughout the 1970s at the expense of the Technical, Natural and Agricultural sciences. This growth can largely be explained as a side-effect of a stronger growth in student numbers within these areas. However, the direct link between student numbers and the research floor funding was abandoned in 1982, and this change immediately stopped the relative growth in these areas (Aagaard 2011). Instead an increasing share of the funding started to be allocated as strategic research grants through large scale programs. As we will highlight in the next section, and as can be seen from figure 3, this subsequent growth in earmarked program funding in particular benefitted the Technical Sciences throughout the 1980s. Secondly, it is also noticeable that the Medical Sciences during the latter half of the period have experienced a very significant increase in its overall share of the public Danish research funding - largely at the expense of the Natural Sciences and the Technical Sciences. As a result the Medical Sciences have since 2008 received close to a third of the total funding of public research in Denmark.

Figure 3 Long-term development in R&D expenditures between main scientific areas in the Danish public sector. Shares in percent.



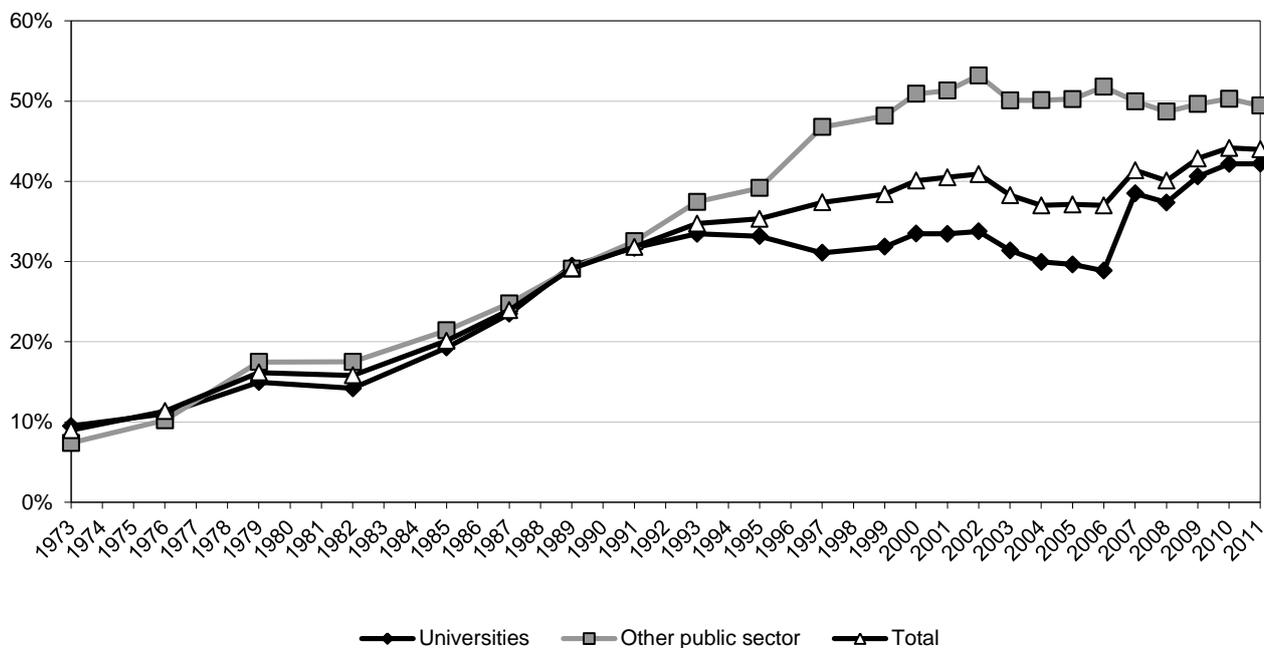
Growth in the external funding and changes in the composition

Other interesting shifts in the Danish development have taken place both in the balance between floor funding and the external funding and in the composition of this growing external funding. As illustrated in figure 4, up until the late 1970s the funding of public research at the universities was almost fully dominated by floor funding with very few strings attached. These grants were in general allocated based on input factors with student numbers as the main criteria. Also the funding of the GRI sector was dominated by floor funding, but the research within these institutes was closely linked to the needs of the sector ministries supplying the funding (Aagaard 2011).

When the direct link between student numbers and floor funding was abandoned in 1982, an activity-based funding system was initially introduced for education, but no alternative could however be agreed upon with regard to the allocation of the floor research funding (Aagaard 2011). This lack of agreement was part of a more general dissatisfaction with the overall research policy in the early 1980s. The public Danish research system was throughout this period perceived to be in a state of crisis and it was argued that major reforms were needed in order to increase integration and cooperation with the outside world in general and the private sector in particular (Grønbaek 2001). In addition, university research was seen to suffer from a lack of competition, environments of sub-critical mass and lack of mobility. These issues were perceived as serious dysfunctions of the system considering the emerging policy belief that renewed industrial growth should be based on key technologies such as information technology, biotechnology and materials science (Aagaard 2011, Grønbaek 2001). As a result a strong growth in earmarked strategic program funding of

research took off during the following years. A major part of this program funding was placed in special committees outside of the existing academically oriented research council structure.

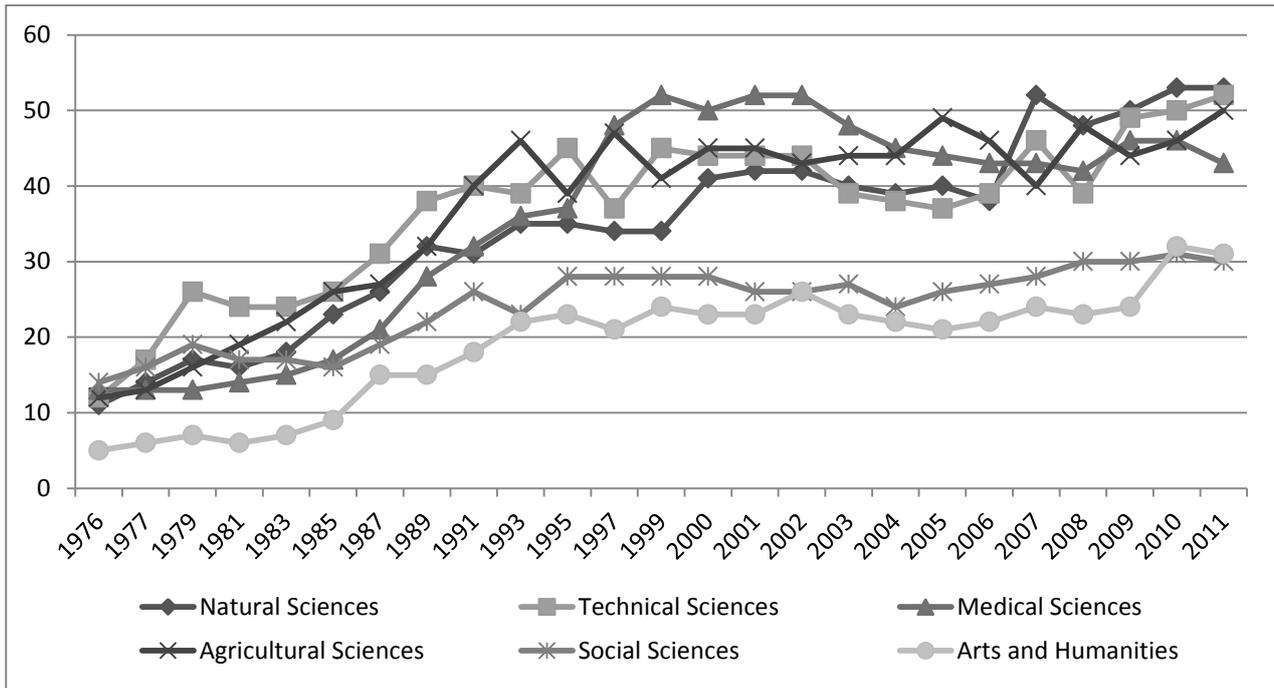
Figure 4: Long-term development in the annual shares of the R&D expenditure in the Danish public sector which are externally funded, divided between universities, other public sector research institutions (GRI,) and the total proportion of external funding



Source: Lauridsen & Graversen (2013).

As figure 4 above shows, the share of external funding for the system as a whole thus increased from 11 percent in 1976 to 35 percent in 1993. As no overhead system was yet established in this period the drastic shift towards more external funding was affecting the use of a large proportion of the floor funding as well - in order to cover indirect costs and demands of co-funding by the institutions. The changes did, however, affect the different main scientific areas in quite different ways as figure 5 shows. Not surprisingly, the Humanities and the Social Sciences were not as affected by these changes as the STEM areas where the shift towards external funding was very significant for almost a twenty year period up until the mid-1990s. It can also be noticed that the share of funding in competition for these areas has fluctuated quite a bit throughout the period due to programs being established, programs running out and new programs coming into play. For some of these areas the funding has thus been lacking long term stability although the overall level has been high and continually growing.

Figure 5 Long-term development in the annual shares of the R&D expenditure in the Danish public sector which are externally funded, divided between main scientific areas.



By the early 1990s it was becoming increasingly clear that the strong growth in earmarked funding was creating new problems in terms of imbalance and fragmentation and a number of influential internal and external actors thus started to jointly work on solving some of the most pressing problems (Aagaard 2011). As a result of this work three important systemic changes were implemented during the early 1990s which reversed the development towards strategic funding in competition somewhat. First of all, a political consensus was reached that the balance between floor funding and external funding should be maintained at the level that was reached at this point (Aagaard 2011). It was a general impression among these stakeholders that a further shift towards strategic program funding would be harmful to the overall balances of the system and would threaten diversity, risk taking and the long term perspective of the research activities. Hereby the relative growth in program funding stopped and as figure 3 shows this led to more than a decade of relative stability in the balance between floor funding and external funding for the universities. In addition, an overhead system was established in 1995, further reducing the pressure on the floor funding. As a third important change the so-called Danish National Research Foundation (DNRF) was created with effect from 1993 to supply long-term of support new “centres of excellence” solely based at academic quality criteria. The DNRF was set up as an independent body with the responsibility for funding research of the highest calibre. At its establishment, the DNRF received a start-up capital of 2 billion DKK (approximately 268 million Euro)¹. These initiatives were all important elements in a general academic reorientation of the system after a decade dominated by

¹ Following a legislative amendment in 2008, the DNRF received an additional 3 billion DKK (approximately 402 million Euro). The annual level of distribution aims at an average of 400 million DKK (approximately 54 million Euro) corresponding to about two percent of total public research expenditure. Since its establishment, the DNRF has supported Danish research with 6.2 billion DKK (approximately 830 million Euro) primarily through its main funding instrument: the Centre of Excellence scheme (CoE) (Evaluation of the Danish National Research Foundation 2012).

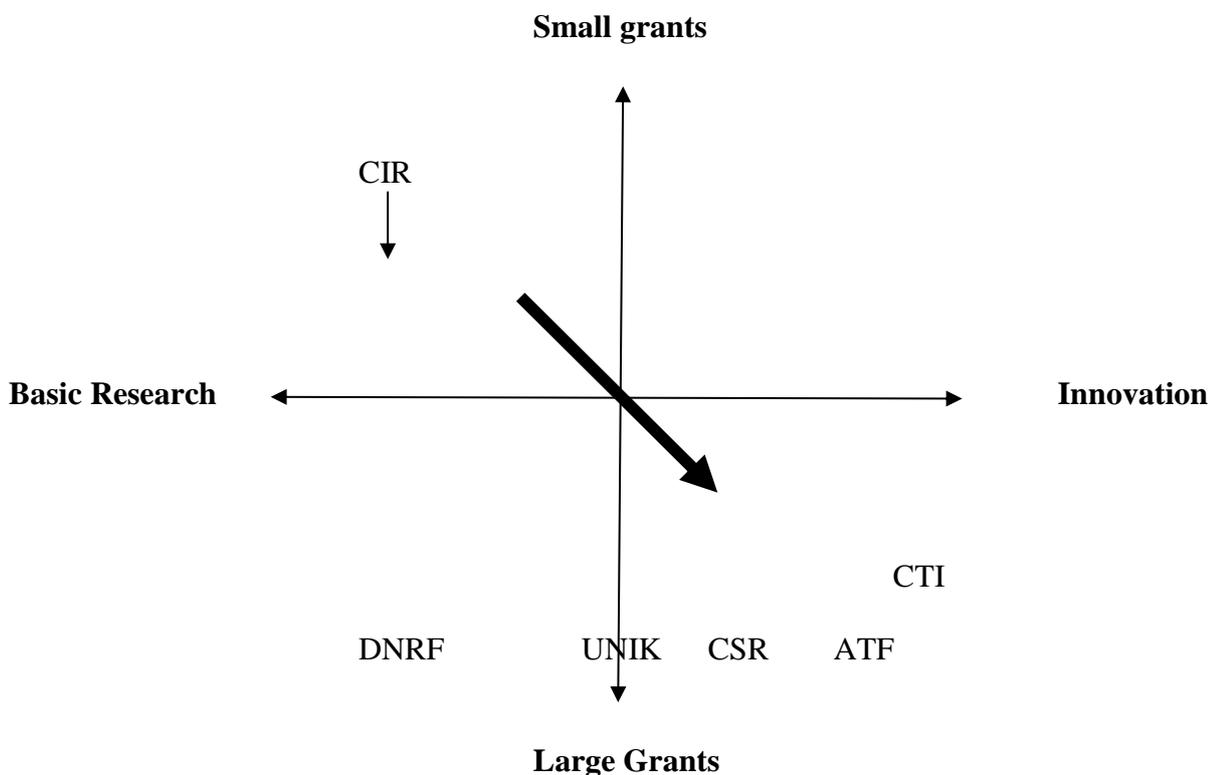
strategic research. It is, however, noticeable that also the DNRF was placed outside of the traditional research council system which still was distrusted by the political system. These trends were however not mirrored completely within the GRI sector. While the university sector and GRI sector followed the same pattern up until the early 1990s with regard to the balance between floor funding and external funding, it started to differ in the following period. While the growth in the share of external funding started to stabilize and even drop for the university sector up until 2006, it continued to grow for the GRIs. Since then a significant growth in the share of external funding has been experienced within the university sector as well as we will return to below.

Due to the political distrust mentioned above several attempts were made during the same period to reform the academic research council system. The system was generally considered to be too academically and disciplinary oriented, too closely connected to the universities, and too unwilling to make real selective proactive allocations of the research funding based on both societal needs and research quality criteria. Instead it was the impression that notions of equity between institutions and main scientific areas were given too much emphasis and that the research funding accordingly was spread too thinly (Aagaard 2011). But even though the political system wished the research councils to play such a mediating role between politics, society, industry and research, they - in the eyes of many stakeholders - primarily served to maintain the autonomy of science (Grønbaek 2001). A number of changes proposed by the Government in the late 1980s and again in the mid-1990s thus aimed at loosening the disciplinary and institutional linkages of the councils and, correspondingly, to strengthen relations between disciplinary, sectoral and industrial research. The quite radical proposals of the establishment of completely new research council structures with fewer and more interdisciplinary councils, did however lead to quite strong counter mobilization. As a result most of the proposals were blocked and only limited changes were carried through. In both instances the strong academic orientation of the system as a whole was accordingly maintained – at least for a while longer (Aagaard 2003).

In late 2001 a new Danish government took office and started a sweeping reform-process including a far reaching management reform of the universities, a transition to a more competitive and more strategic oriented research funding system, a large scale merger process and the introduction of a new performance-based floor funding model to mention just a few (Aagaard and Mejlgaard 2012). It was (again) argued by the government that there was too little competition for research funding and that the money was spread too thinly. As a consequence the government aimed for a turn the existing 65/35 balance between floor funding and external funding towards a 50/50 allocation (Danish Government 2006). Again, a radical restructuring of the academic research councils was proposed at first, but also this proposal turned out to be too far reaching for many actors (Aagaard 2003). Instead the government chose a different strategy running in two separate phases. In the first phase it was chosen to establish three new strategic or innovation-oriented research funding channels alongside the traditional research council system rather than tackling the existing council structure head on. The new funding mechanisms included a Council for Technology and Innovation (CTI, established in 2002), a Strategic Research Council (CSR, established in 2004) and an Advanced Technology Foundation (ATF, established in 2005).

This layering strategy subsequently opened up for a second phase where gradual changes in the composition of the funding were carried through as the result of differentiated growth between the traditional elements of the funding system and the new ones. In headlines these changes were dominated by three tendencies: a shift from floor funding towards external funding, a shift from basic research towards strategic research, and finally a shift from the funding of many small projects towards fewer and larger projects (Aagaard 2011; Aagaard and Ravn 2012). The latter two of these tendencies are illustrated in figure 6 below showing how all the new competitive funding mechanisms established in the period 2002-2005 were placed in the quadrant of the figure emphasizing large, strategic or innovation-oriented grants. Also the Council of Independent Research (CIR) (the umbrella organization consisting of the traditional academic research councils) was in this period forced to allocate its grants in fewer and larger portions. Finally, an additional layer was added to the funding system when the so called UNIK-initiative was established in 2009. The initiative first of all aimed to strengthen the strategic capacity of university management by offering competitive funding to encourage Danish universities, as institutions, to strengthen their strategic efforts to prioritise research and to create a distinctive research profile².

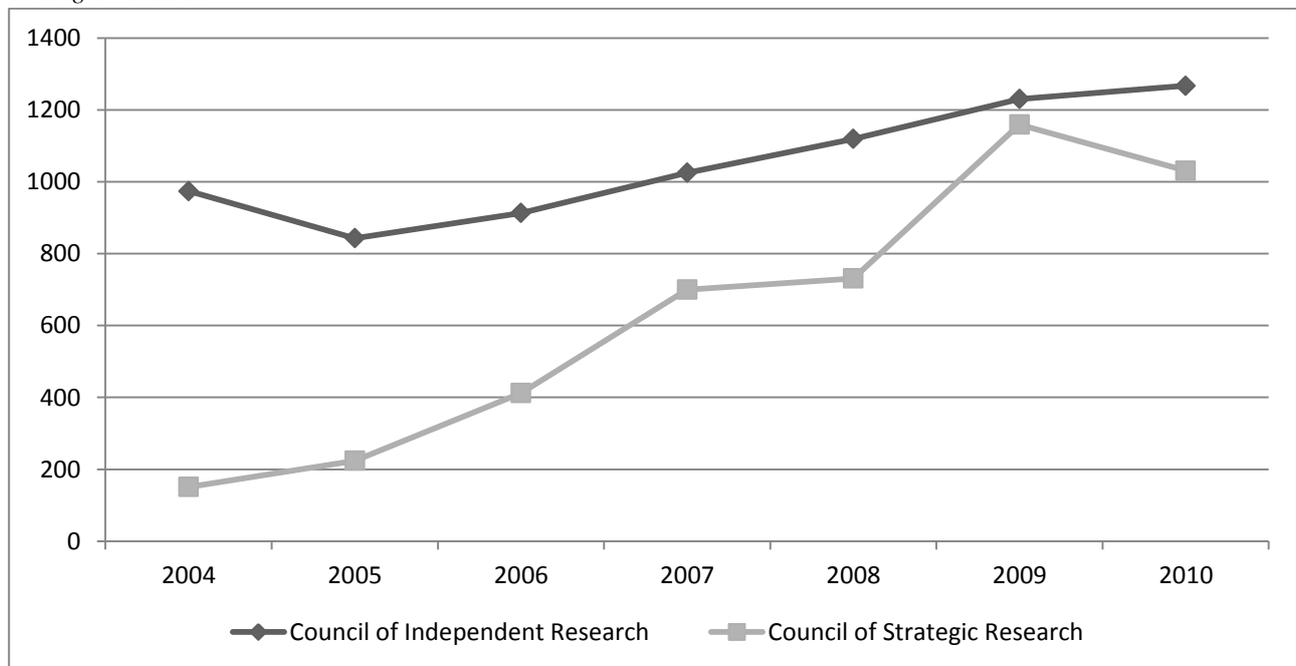
Figure 6 Shifts in the composition of funding since 2001 due to additions to the system



² Proposals from the three most research intensive Danish universities were eventually funded (two UNIK-centres at Copenhagen University, one at Aarhus University and one at the Technical University of Denmark). These universities received approximately DKK 120 million for each centre (2009-2013).

As mentioned above, the development was not limited to the establishment of new funding mechanisms but was also strengthened by differential growth between the traditional mechanisms and the newly established ones. To exemplify this development Figure 7 shows the allocation of funding for the Council of Independent Research (CIR) and the Council of Strategic Research (CSR), respectively. As can be seen the CSR played a quite marginal role in terms of funding volume at the time of its establishment in 2004, but during the following years this council grew at a much larger pace than the CIR, thus gradually altering the institutional balance of the system. The same pattern can be found with regard to the two other newly established funding mechanisms (Aagaard and Ravn 2012). Most recently, the CSR, The CTI and the ATF have been merged into a united organization labelled ‘Innovation Fund Denmark’. In 2015 this Foundation has an overall budget just short of 1.6 billion DKK (www.innovationsfonden.dk).

Figure 7: Development in the volume of funding between the Council for Independent Research and the Council for Strategic Research



As another result of the overall changes the stable balance between floor funding and external funding which had been kept throughout the 1990s and the early 2000s was gradually tipping towards the external funding. As can be seen from figure 4 this development became quite significant from 2007 and onwards. Although the 50/50 balance which the government aimed for has not been reached yet a new balance appears to have been found fluctuating around 55 percent floor funding and 45 percent external funding of the public research.

Finally, in addition to these changes also the allocation of the floor funding was reformed as well. In 2010 a performance-based floor funding model was introduced after lengthy and heated negotiations. The model which is highly inspired by the Norwegian publication based allocation

model, does not, however, redistribute large shares of the floor funding. The figure is not fixed from year to year but has fluctuated around 2 to 3 percent since its establishment (Schneider and Aagaard 2012). In reality, the new model was just an extra layer on an existing system which redistributed a small part of the floor funding based on student numbers, ph.d.-production and the acquisition of external research funding. This part of the system was introduced in 1997 (Aagaard 2011).

5. Discussion and concluding remarks

Overall, the present analysis has shown the development of a Danish research funding system largely mirroring the international trends outlined in the literature. There are however some deviations. The overall volume of the public funding has shown an almost uninterrupted steady growth throughout the period although with signs of levelling off during the 1970s. But contrary to many other countries the funding in Denmark has never reached a steady state and even in the wake of the financial crisis the growth continued. We do however in the most recent years not covered by the time series in this article see signs of a current levelling off. Similarly, also Denmark has experienced a quite substantial shift from a very dominant floor funding model to a split funding model with several layers of funding mechanisms established at different points in time. Interestingly, the core of the external research funding system, the traditional academic research council system, has remained almost unchanged throughout the period from its establishment in 1968 until today. Although an almost permanent political distrust has characterized the relationship throughout the period and although several attempts have been made to radically restructure the academic research council system it has shown a quite remarkable resilience. This change resistance has, however, not been without costs. When it has been impossible - or too costly - for decision makers to change the academic research council in system itself they have found other channels to reach their goals by circumventing this part of the council system. This was seen in the 1980s when the large strategic research programs were placed in special committees outside the academic research councils. It was seen again in 1993 when DNRF was established as an independent foundation and finally it has been seen in period from 2001 and onwards where a number of new funding mechanisms have been established alongside the academic research council system, and where these new councils and foundations subsequently have experienced stronger growth. As indicated, these overall lines of developments have not only led to a shift towards external funding at the expense of floor funding, but also towards fewer and larger grants and to a shift from the funding of traditional basic research towards more strategic or innovation oriented research.

By applying an updated historical institutional framework the analysis thus shows how a long series of gradual and marginal processes of institutional change running through parallel dimensions – occasionally supplemented with more radical change – over time has accumulated to a rather far-reaching transformation of the Danish research funding system as a whole. Central institutions such as the floor funding and the academically oriented research council system have continually been reproduced in this process, but at the same time new funding and steering mechanisms have been layered on top of existing institutions as a consequence of new policy ideas, new demands and new notions of accountability. Over time this process has resulted in a multi layered and complex system

of funding in which both classical and emerging research policy ideas co-exist and continue to play central roles.

The analysis also reveals an interesting pattern with regard to the outcome of different reform strategies. As shown in table 1 the attempts to radically change the traditional academic research council system have all failed, while most of the more gradual reform strategies where layering and displacement through differentiated growth have been put to use have led to transformative and long lasting changes of the overall funding system.

Table 1 Research funding initiatives, types of change and result

Reform attempts	Type(s) of change	Result
1968: Establishment of the academic research councils	Layering	Implemented, but of marginal importance
1985: Initiation of the strategic research programs	Layering and displacement	Transformative change, but gradually implemented
1989: Reform of the academic research council system	Attempt to radically change the overall structure	Failure due to strong counter-mobilisation
1991: Establishment of DNRF	Layering	Implemented
1997: Reform of the academic research council system	Attempt to radically change the overall structure	Failure due to strong counter-mobilisation
2002: Establishment of The Council of Technology and Innovation	Layering and subsequent displacement through differentiated growth	Implemented
2003: Reform of the academic research council system (1)	Attempt to radically change the overall structure	Failure due to strong counter-mobilisation
2003: Reform of the academic research council system (2)	Layering of CSR and subsequent displacement through differentiated growth	Implemented
2004: The Advanced Technology Foundation	Layering and subsequent displacement through differentiated growth	Implemented

Overall, the analysis thus shows that while there is a high degree of path dependence in the funding system and while central institutions show a high degree of change resistance, it is still possible for reform advocates to implement transformative changes as long as they apply more gradual layering and displacement strategies. These strategies naturally require longer time horizons than more radical structural changes, but they do in many instances lead to substantial and long lasting transformations which not from the outset provoke strong counter mobilisation. But obviously, the choice of strategy is not the only explanation of the observed changes. In particular with regard to the changes implemented in the Danish system in the period after the turn of the millennium a number of other explanations should also be considered. This period has, first of all, been characterised by a quite strong ideational pressure for changes brought forward by influential international organisations such as the EU and the OECD and we have thus seen similar

developments in many other countries – irrespectively of change strategy. Furthermore, it most likely plays a decisive role that the period in question in Denmark has been characterised by a strong growth in the overall funding of the public research activities. All else being equal it is much easier to implement layering and displacement strategies when additional money is allocated to the system.

As a final remark, we want to return to the introduction of this article where we highlighted the current high scientometric performance of the public Danish research system. An interesting question is whether we can draw a direct link between the changes in the funding system outlined in this article and the development in the Danish national research performance? The short – and perhaps not unsurprising – answer is no. We have explored these links in detail elsewhere (Aagaard and Schneider, forthcoming). Here we show that although the funding system constitutes the single most important factor in enabling, steering and directing the public research activities, most potential correlations to changes in research performance are far from straightforward to interpret. The main explanation is that we are dealing with highly complex, multi-layered systems tightly integrated with the surrounding international research community and with types of funding changes which often have both direct and indirect consequences and which furthermore often are characterised by substantial time-lags between cause and effect. The conclusion is not that changes in funding mechanisms and general frame-conditions are unimportant – far from - , but rather that our current knowledge of the relationships between these factors and performance are fragmented and inconclusive. To understand the development in aggregated performance measures we first need to examine the micro foundations of these developments by exploring how funding changes affect actual research practices. Concepts such as *authority relationships* and *protected space* appear to represent promising theoretical contributions to the exploration of these types of questions (Whitley and Gläser 2014). A central precondition for venturing further down this road is, however, a better and more detailed understanding of the character and direction of the changes on the input side across a whole range of countries. As such, this article represents one of the first steps in building a solid foundation for the exploration of these issues.

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Conflict of interest

None

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