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Innovation and Dynamics in Public Research Environments in Denmark –

a Research Policy Perspective

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Abstract

The theme for this article is to outline and summarise the factors that characterise dynamic and innovative research environments. The focus is on the relationship between organisation and leadership of research, research processes and environmental conditions on the one hand and research quality and outcome on the other. The article takes as a starting point the results of an empirical study of 15 innovative and dynamic university research environments and other public sector research environments in Denmark. It points to the common features that characterise the framework of research, research processes, working and social milieu of research environments and their influence on research. Furthermore the article has a research policy oriented approach.

The innovative research environments serve as a possible reference for good practice for research agents attempting to promote innovation and further develop a dynamic science base. The analysis of the factors that characterise dynamically innovative research environments might be a significant tool for management of research institutions as well as for policy makers in their attempt to foster innovative and dynamic research environments.

1. INTRODUCTION

The empirical background for the article is a study initiated by the Danish Council for Research Policy[1] and carried out by The Danish Institute for Studies in Research and Research Policy. The survey was carried out in autumn 2001 and the results were presented to The Danish Council for Research Policy in March 2002 (see Graversen E. K. et al. 2002).

The Danish Council for Research Policy selected 15 dynamic and innovative research environments representing all faculties for the study and including university institutions, research centres, networks and public sector research units. The council suggested the 15 units as examples of innovative research environments based on their evaluation of these in connection with other advisory work. In the study every single unit was defined as a research environment. Researchers in the studied environments were engaged in basic as well as in applied research activities.

The objective of the study was to find out what characterised dynamic and innovative research environments, in order to utilise these environments as examples for good practice. The study aimed to explore the factors that constituted innovative and dynamic research environments in Denmark and to further explore how factors within research environments as well as factors in the broader environment such as research policy influenced organisational structures, research activities and outcome. The study looked at multiple elements within the research environments i.e. input, structures, funding, physical and social environment, research processes and communication patterns and networks in relation to external influences.

1.1. Point of departure

In the literature, two distinct perspectives have developed on the way research is influenced and controlled. On the one hand the internalist perspective, which outlines the development of research as determined by structures and processes within the scientific community. On the other hand the externalist perspective, which perceives the development of research as influenced by structures and processes in society as a whole. Within these two perspectives there is a variation of different theories that predominate. Theories within the two perspectives differ with respect to the mechanisms of control and influence that they consider important (For a more detailed presentation of the different perspectives see Foss Hansen 1988).

[1] For detailed presentation of the Danish research council system see Foss Hansen (1996), Benner & Sandström (2000) and Bertilsson (2001).

The internalist perspective in general is often criticized as it first and foremost focuses on the internal to the research community factors. The external frame factors influencing research are not subject to analysis in this approach, which means that the internalist perspective concentrates on only one dimension of the scientific community.

The externalist perspective is more open and complex than the internalist. It is hereby more equivocal. Within this perspective different theories exist which as a common feature outline development of research in the context in which this operate.

Both approaches, far from opposing each other, are largely complementary. The analysis of the results of the survey presented in this article seeks to combine the two perspectives and work on this complementarity as the Model for Studies of Research Environments, which has been used in this study, points out (see figure 1). Focusing on the interaction between internal and external factors has allowed a better understanding of the highly complex mechanism of innovation and dynamics generation in research environments.

In this article emphasis is though put on the research policy approach, which concentrates on policy aspects and the influence of policy making on research. This is done in an attempt to contribute to the debate on policy strategies in order to provide policy tools for different research agents and offer some suggestions for improving the ecology of research.

1.2. The research policy perspective

The relationship between science and society has changed significantly during the last decades and the science policy paradigms have changed accordingly. This development has been addressed in a number of contributions to the field of science policy studies (Gustavsson, Elzinga & Jamison 1994, Gibbons et al. 1994, Ziman 1994, Guston 2000). The reviewed literature illustrates that the organisation and functioning of the research system as well as the design and managing of science policy is still changing rapidly and that the demands to the research system are increasing in most of the countries[2].

The research policy perspective considers research units as political organisations and the influence and control of research as being determined by contextual factors i.e. policy-making. The external influence depends on the degree of bureaucracy, policy-making bodies practice on research institutions. The arguments are on the one side that high degree of autonomy and freedom is the basis for research development and innovation, and that

[2] For a more explicit presentation of the latest development in the field of science policy at European level see Science Policy, Setting the Agenda for Research, STRATA Accompanying Measures, Managing with Uncertainty in Science Policy, Proceedings from MUSCIPOLI Workshop One. The Danish Institute for Studies in Research and Research Policy 2001/8.

policy-making should have this as a point of departure, and on the other side that research should be planned, organised and controlled by political means.

There are though some fruitful and more profound arguments in the literature that represent a more differentiated picture of the research policy perspective (see Cheng & McKinley 1983, Foss Hansen 1988). These point to beneficial effects of having a differentiated policy depending on the discipline, the nature of research fields and how clear and well definable the research subjects in question are. According to these perceptions research in some phases and within some disciplines could with great benefit, be subject for external influence. The standpoint of this approach is that the policy challenge is to create conditions for research diversity and furthermore, to ensure room for basic and innovative science.

1.3. A Model for Studies of Research Environments

The starting point for the study Dynamics and Innovation in Universities and Public Research Institutes in Denmark – An analysis of the characteristics of dynamic and innovative research environments was to use a theoretical approach that seeks to combine the two perspectives (internalist and externalist) in the analysis of the factors that interact in research environments and influence research processes and activities (See Scott 1981, Dahllöf 1982 & 1991, Scharioth & Gizycki 1986, Andersen & Foss Hansen 1985-86, Clark 1987, Foss Hansen 1987).

A Model for Studies of Research Environments (The MSRE) was adopted for this analysis. The model was developed and tested in connection with an earlier comparative study of research environments in Scandinavia. It has so been modified to correspond to the needs of the present study (for details see Kalpazidou Schmidt 1996).

The MSRE (figure 1) focuses on the capacity, the organisation and the research activities and processes taking place within research environments as well as on environmental conditions outside the institutions that influence organisation and research processes. Conditions that are identified outside the units (such as societal factors, research policies and the academic market) could have a direct or indirect, although significant, influence on research activities and outcome, as previous studies on research environments reveal (Dahllöf 1982, Kalpazidou Schmidt 1996, Jørgensen T. B. et al. 1998, Jacobsen B. et al. 2001,).

The MSRE opens up for analysis of elements of input, structure, process and outcome. The study becomes more complex but at the same time more significant.

According to the MSRE a research organization transforms an input (grants, qualification of research) through a process to an outcome (dissertations, publications, postgraduate students, patents, rewards). Research is determined though by different processes in the research environment such as research activities, communication patterns and networks, conditions for research, working climate, recruiting systems and rewards, education and socialisation of researchers.

Elements of structure and elements of process interact. The preconditions of production are defined by the structure of an organization, but in a longer perspective structures can be influenced and changed by processes within a research environment as well as by other external factors.

Furthermore, the MSRE focuses on the relationship between science and society and emphasizes the external factors influence on research. According to the model external factors make a framework for research activities. This relationship is though interactive. This means that changes in conditions in the society as a whole have an influence on research and vice versa.

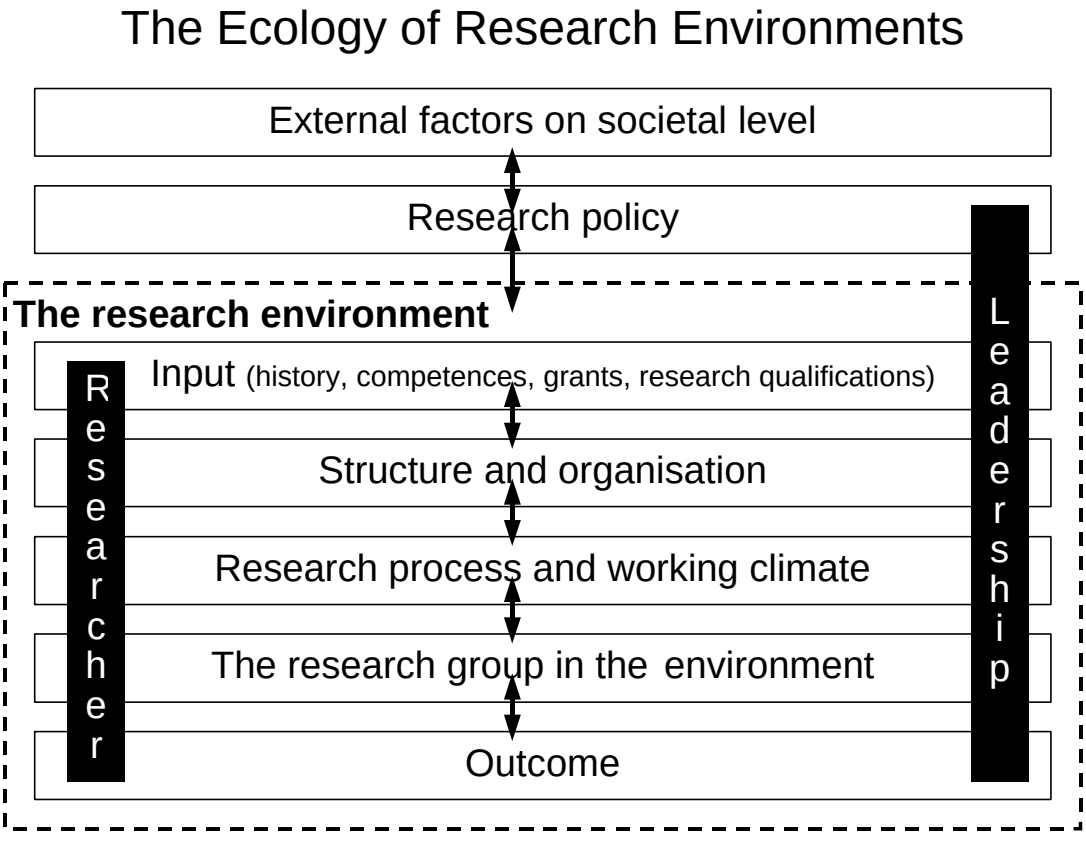

Figure 1. A Model for Studies of Research Environments (MSRE)

2. THE STUDY

Dynamics and innovation are not new terms in research or in the context of research policies for that matter. Dynamic, innovative and well functioning research environments have been frameworks for excellent research carried out in many fields. The following analysis has as an intention to give a better knowledge of innovation processes in research environments for use in the decision-making by illustrating the common characteristics of these frameworks.

The studied research environments represent all the fields of science and technology covering basic as well as applied research. Some environments are small, others large. Some comprise institutes; others departments, while some are either centres or networks. Obviously, the selected research environments comprise only a part of the dynamic and innovative environments in Denmark.

The study is based on surveys carried out among researchers and research leaders in the environments in focus. A combination of qualitative and quantitative methods was adopted. The analysis is furthermore based on in-depth semi-structured interviews with the leadership of the research environments and questionnaires send to the researchers as well as on data assembled from university and research institutions documents and research records. Moreover, the study has had as a point of departure the history and development of the research environments. This was done in order to find out the origin and roots of the dominant research traditions and leadership styles and the way different personalities have shaped each of the research environments.

2.1. Factors that characterise dynamic and innovative research environments

The empirical study reveals that the common features of dynamic and innovative research environments comprise the following:

- Clearly formulated research strategies and research objectives. Strategic planning.
- Research strategies encompass planning and coordination of activities, formulation of target areas, and prioritisation among research areas and research projects.
- Distinct research profiles. Researchers in these environments are predominantly engaged in research areas that are unique to Denmark.
- Leadership and management focus on research, quality and competence development.
- Leadership and management focus on organisational efficiency and productivity.

Furthermore, dynamic and innovative research environments have active, transparent and competent leadership based on modern personnel management styles. Leaders are active within the research environment, in relation to the political system and to the society as a whole.

Dynamic environments are often shaped against the backdrop of inspiration from abroad. Foreign research environments are templates for environments at home. Typically, leaders are inspired by experiences gained in foreign scientific environments through research postings. Inspiration concerns in particular physical planning and organisation of research. In many instances inspiration from abroad influences cognitive processes as well, that is to say influences the choice of research fields and subjects. It is evident that interaction with the international research environments is of outmost importance for the dynamic and innovative environments. Not surprisingly, most of the studied environments are also internationally well known and professionally well recognized. Building on international networks is a decisive factor for these environments. Knowledge transfer is considered a precondition for innovation.

The studied environments have excellent research frameworks and they attract an adequate financial support. These environments can so draw on substantial external resources, which contribute to the their innovatory dynamism. External funding from the private or public sector further stimulates teamwork and cooperation with other environments in Denmark and abroad. External funding reinforces inter-disciplinary initiatives and facilitates the process of recruitment of new researchers. An interesting observation was that most of the environments chosen rely substantially on external resources. The existing levels of research activity could evidently not be maintained without this kind of funding.

Dynamic environments build on a flexible research organisation where internal cooperation based on specialised teams has a high priority.

Dynamic and innovative environments build on well-defined, transparent staff policies, which set out to encourage, support and assist the process of creating professional contacts, often in the form of networks – especially international networks. These initiatives set the framework for researchers' professional development. Staff policies are based on the principle of research autonomy. The degree of "professional freedom" is in general greatest during research processes and less when choosing research subjects due to the fact that the studied environments are characterised by distinctive research profiles. This factor restrains possibilities of working within a wider range of research areas.

Dynamic and innovative environments boast a scientific elite. The elite ensures the overall quality of research and assists young researchers – both in the socialisation process and in relation to the different markets surrounding them (such as the publicity market and the resource market). The system further rewards well-performed research using different incentives and reward mechanisms. By use of the same mechanisms the organisation aims to make research environments equally attractive to Danish and foreign researchers.

In addition, the studied research environments have a clear and transparent recruitment policy that is built on a solid core of senior competences and young researchers as well. Leadership focuses on identifying and recruiting energetic, enthusiastic and committed researchers. The age difference between researchers – which means interaction between several generations under the same roof - is clearly promoting innovation. The study reveals that recruitment policy is a significant factor when seeking promoting innovation and dynamics in research environments.

The environments in focus are characterised by a good working climate. The organisations are based on internalised norms and research traditions. At the same time a pluralistic approach prevails. This approach contributes to openness toward new ideas, methods and research traditions. Furthermore an ongoing dialogue on research tasks, research theories and research methods was established in these environments. The dialogue and openness to new ideas clearly promoted innovation in research.

The research environments featured in the study have an organisation that is flexible in relation to external factors as well. The organisation is characterised by an ability to adapt to external factors and a sensibility towards changes in the surrounding society. Dynamic environments consider it as important and they are able to promote research groups' interest in society. The environments, as it is revealed in this study, are open to the surrounding society and the majority of environments maintain good connections to the private sector and the political establishment. It has to be underlined though that this does not unequivocally imply that all research environments in the study have close cooperation with the private sector. In some environments researchers are working on subjects that are not of relevance to the private sector.

2.2. Organisation of research in innovative and dynamic research environments

Focusing on the organisation of research more closely, the following is apparent:

Dynamic and innovative research environments are organisations without clearly defined boundaries. These environments are open, somewhat "fluid", and usually non-conformist.

They comprise a core group of researchers, and a group of sometimes closely connected colleagues with a somewhat different research profile. The innovative environments consequently do not emphasise in particular their outer boundaries within the organisational context. Instead they concentrate on defining internal factors such as norms and values, cooperation and quality. This policy also becomes a predominant factor in the process of recruiting new researchers. The organisation of research influences the research activity and development of the units. In principle the organisation structure emphasises leadership and the significance of the research group. This means that research groups and not individual projects are favoured when it comes to allocation of resources.

Well functioning research environments have, as earlier described, as a point of departure strategic planning and well defined goals. Nevertheless, it is primarily the leadership that formulates goals and strategies. It is not always the case that every single researcher is acquainted with the common goals that have been identified. These goals, by the way, vary between the different environments – some have overall goals, others very specific formulated objectives. As a general rule however, leadership of dynamic and innovative research environments work on the basis of well-formulated priority areas.

Furthermore the activities of the research environments studied here have usually as their starting point demands and needs originating in the surrounding society. Research leaders combine societal demands and needs with the professional interests of the group. This evidently increases the potential for obtaining external funding from several different sources. It should be noted that to a large extent research environments are dependent on external resources and they have developed mechanisms and procedures that allow them to deal with funding issues. It has to be said that the study of dynamic and innovative research environments reveals that conditions within the framework of research environments – such as the market for academic employment and research policy initiatives – are highly important with respect to recruitment and funding, and so ultimately for the very development of research.

The informal structure of dynamic and innovative research environments – namely factors such as dialogue and communication, network building, internalised norms, values and traditions influence to a large extent the content of research activities, the quality, international visibility and the productivity of the units. The environments' demography and staff composition, with different personalities interacting within a given framework, have a significant influence on the organisation of research, on leadership styles as well as on research processes.

The organisations of the studied environments emphasise and facilitate communication with international research and international network building. Reference groups and potential networks to a high extend in these environments are to be found internationally, as the high degree of research specialisations also implies.

The study showed that the research environments' external framework (i.e. the institutional organisation of the universities as well as the sector research institutes that forms the broader framework for the activities of the units) has been focusing on and actively promoting the development of research.

2.3. Leadership and management of dynamic and innovative research environments

The study of leadership of dynamic and innovative research environments shows that:

Leaders of the environments studied are active and respected researchers themselves with adequate leadership qualities and a considerable impact on relations to colleagues. Additionally it was found that the majority of managers have been instrumental too in creating and shaping the research environments, they were working within. Managers of innovative environments were found to have a significant possibility for influencing and changing research environments within the existing organisational frameworks. The influence is partly a consequence of leaders other professional activities, such as membership of university committees and research councils.

Leaders consider it essential to have clearly formulated research strategies and well-defined research goals. These goals vary in respect to the level of detail. Some goals are overall others are more specific. In some cases, the study reveals, that the goals were not written into some form of description of the institutional profile.

Leaders map out the research framework and the research environment. They take active part in securing the resources, they prioritise the research tasks, formulate the target areas and initiate coordination of activities, encourage cooperation and teamwork, they utilize different incentives and remuneration systems, and they attempt to stimulate and develop competences by offering researchers new professional challenges.

Leaders consider it significant to formulate a clear and transparent personnel and recruitment policy. They usually encourage a non-authoritarian leadership style enshrined in the principle "freedom based on responsibility". In short, they attempt to promote dialogue, communication and openness to new ideas and traditions and a well-functioning social environment. They emphasise, and are very actively engaged in, identifying and recruiting

energetic, enthusiastic and committed researchers. With respect to appointments/recruiting, research managers emphasize three criteria: professional qualifications, interest in the research area and social skills. Many leaders actively work to recruit foreign researchers too – for example at international conferences.

Leaders put focus on quality of research, quality assurance and cooperation with international environments. Leaders regard this as extremely important, especially in relation to young researchers' professional development. Managers from the humanistic and social science research environments taking part in the study specifically stressed the need to focus on research. In these environments research comes usually second to other priority tasks such as teaching and supervising.

Leaders present and emphasise the significance of the work of their environments and their colleagues internationally and in relation to the private sector and the society as a whole. These issues are considered extremely important for the research environments' dynamism and development, not simply because of their impact on funding, but also as these factors have to do with promotion of innovation in a highly competitive international context.

The study also points to the fact that leaders have the opportunity of influencing research policy through their research work on one side -as their research activities are unique for the country- and their participation in different advisory and steering committees and research councils on the other. This suggests that managers of dynamic environments are well represented in the research policy-making system.

In conclusion, as the results of the study reveal, research leaders of dynamically innovative research environments perceive their roll in a remarkable similar way in the decision making process, use similar strategies and tools in order to promote dynamics and innovation in the environments.

3. CONCLUSION AND PERSPECTIVES FOR RESEARCH POLICY

In spite of the fact that research leaders act similar when promoting innovation, the results of the empirical study show, given the wide range of the studied institutions and units, an almost overwhelming differentiation and diversity as a main feature of the research environments. The differentiation depends on factors internal to the units such as the organisation and structure of the institutions, the research cultures, the research traditions, the research profiles and specialization's, the communication patterns, networks and community life on the one hand and context-related socially determined factors external to the departments, such as research policy, national needs and consequently identification of priority areas on the other.

Research environments are complex organisations. Simple input-output methods are not appropriate when studying research processes and innovation. Research activities have different needs and take place in different environments and within differentiated context. Studies of research environments need to combine the internalist and externalist approach as the results of the present investigation points out. The analysis of the mechanisms that form environmental conditions and the different dimensions of the process of innovation could be of significance when creating a well functioning, innovative and productive research ecology.

The main conclusions presented in this article illustrate the importance of the organisation and management of research environments for innovation and dynamics. These have consequently some implications regarding research policies and decision-making.

3.1. Implications for research policy

With respect to the research ecology the analysis has illustrated the fact that what actually characterise dynamic and innovative research environments is their diversity. Research has differentiated needs, is carried out under different conditions and within different frameworks. Creating and developing dynamically innovative research environments takes time and effort. Research on research conditions on the other side has to be intensified in order to support the decision making process and the implementation of a research-based policy.

As to implications for research policy the results of the presented study and the following analysis can be used as a starting point in order to form the ecology i.e. the framework for the development of innovative research. Consequently the following three points are of significance for research policy-making: organisation and leadership of research environments, framework and conditions for research, and resource allocation policy.

3.2. Organisation, management and leadership of research environments:

The survey illustrated that strategic planning, organisation and management of research and coordination of activities are not contradictory to autonomy of the environments and freedom of individual researcher, especially during the research process. By means of planning, organisation and management of research at the research unit level it is possible to generate a higher research outcome. In some disciplines and fields the effect of strategic planning and organisation is higher than in others. The degree of organisation and management of research has to be differentiated depending on how well the research subject is definable on the one side and the degree of consensus among scientists on which methods and approaches to apply on the other side.

Nevertheless, organisation and management of universities and other research institutions need to show flexibility and give room for a broad operational canvas for research leaders as well as researchers in the environments. This should be underpinned by intensive communication and dialogue, both internal and external e.g. between researchers and other interests in society.

Strategic planning is a significant aspect of modern management of research. The organisation could therefore provide research leadership with increased possibilities and opportunities for altering strategies, aims and goals, formulating, changing and implementing priorities and recruiting new talents on the one side, and adapting the research environment and organisation to external conditions and circumstances on the other side. Research leadership should similarly be able to extend projects and appointments and use other necessary measures and tools to manage the ongoing dynamic research process.

Research policy has to focus furthermore on the cooperation between university research, other public research and private sector. It is also important to ensure that the corporate sector is alert and sufficiently informed about options and perspectives for cooperation with university and other public sector research. In this way the private sector could become more responsive to the challenge of cooperating with public research organisations. Tangible incentives for cooperation could be considered. Policy-making bodies could increase efforts finding out how to make better use of the results of public research in an attempt to achieve the knowledge-based society.

Research policy bodies have though to consider that not all research is of immediate use to society, nor can it always directly match the immediate demands and needs of societal demands or the needs of the corporate sector. This is a consideration of significance,

especially when focusing on priority areas otherwise the risk of overlooking innovative research would be too great.

External dialogue and cooperation with other national and international research environments is of vital importance for creating dynamic and innovative framework, both with respect to networking and exchanging of researchers. External dialogue is a precondition for ongoing innovation and renewal in research environments.

3.3. Frameworks and conditions for research:

Frameworks and conditions for research activities need to be adapted to differentiated research requirements. Implementation of policy based on uniformity and the principle of "similar conditions and terms for all fields and disciplines" is not always the best measure to take in the effort to promote innovative research.

Development of the organisation at research unit level has to be initiated. Research management and leadership at this level have to be strengthened. Dynamic research environments have, as the results of the survey show, either successfully created or adapted their framework to be a stimulating leadership tool promoting innovation.

Precondition for innovative research environments when developing frameworks is the local knowledge of research conditions and needs. Leaders of research environments are in possession of this knowledge and are able been respected scientists, to make use of this authority to implement decisions. Research leaders should be given the necessary management tools to be able to make decisions and implement new initiatives locally.

Research leaders should also have the necessary time and room to act as efficient leaders so as to be able to focus on research strategies and implementations. Upgrading management skills could be considered a significant option and an integrated part of the development of research organisations. The role of research leaders should be given higher priority in this dynamic process.

Finally, the organisational framework should give room for new constellations to emerge both as a way of ensuring innovation and as a way to increase inter-disciplinary initiatives.

3.4. Allocation of resources:

Funding mechanisms and forms should vary between the different research environments. Policy makers have to take into consideration that the more uncertain the research tasks, the harder it is to attract external funding. In many cases governmental funding is a necessary

precondition for subsequent research success. Ultimately this success will attract external funding for continued research efforts.

External funding is often time limited and ‘impatient’, meaning that this form of funding assumes that ‘mile stone’ results are already achieved. Before these areas can benefit from external funding, research environments need basic governmental funding in order to explore new research areas. Successful external funding requires on the other hand that a high quality research environment already be in place. As the study shows, researchers in dynamic units are of the opinion that research fields, that attract temporary political attention, should not be over-financed to the detriment of other research environments with a medium to long-term potential.

Research policies should be differentiated with respect to disciplines, research fields and subjects. Fields with well-defined paradigms could receive different treatment in policy-making compared to areas where paradigms are not as yet firmly rooted. Research policies could prioritise research fields in the former area, while the latter should be allowed considerably more scope and freedom, both in terms of choosing research subjects, in terms of funding and expectations to immediate efficiency as well.

Research environments could be given a greater scope for introducing varying types of incentives at group level, especially collegiate incentives and access to direct and indirect remuneration systems, in an attempt to support and strengthen selected research areas.

3.5. Concluding remarks

The study of innovation and dynamics in public research environments in Denmark illustrates that the characteristics of dynamically innovative research environments are to be found on factors internal to the research environments as well as external factors. This implies the influence of policy-making bodies and the significance of policy making for research processes and outcomes.

Although the results presented in this article are limited to a specific context, taking in to consideration the differentiation of research environments, the implications for policy, especially on management and organisational level is considered useful for the debate on research policy in a broader sense.

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