Research environments

Innovation and dynamics in public research environments in Denmark: a research-policy perspective

Evanthia Kalpazidou Schmidt, Ebbe Krogh Graversen and Kamma Langberg

The theme for this article is dynamic and innovative research environments and the factors that characterise them. The focus is on the relationship between the organisation and management of research, research processes and environmental conditions on the one hand, and research quality and outcomes on the other. The article takes as a point of departure the results of an empirical study of 15 university and other public-sector research environments in Denmark. It identifies the features that characterise the framework of research, research processes, the working and social milieu of research environments and their influence on research in a smaller European country from a research-policy perspective. Innovative research environments could serve as references for research agents attempting to promote innovation and further develop a dynamic science base.

Evanthia Kalpazidou Schmidt, Ebbe Krogh Graversen and Kamma Langberg are at The Danish Institute for Studies in Research and Research Policy, Finlandsgade 4, DK-8200 Aarhus N, Denmark; Tel: + 45 8942 2394; Fax: + 45 8942 2399; E-mail: eks@afsk.au.dk.

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THE EMPIRICAL BACKGROUND for this article is a study by The Danish Institute for Studies in Research and Research Policy initiated by the Danish Council for Research Policy.¹ The survey took place in autumn 2001 and the results were presented to The Danish Council for Research Policy in Spring 2002 (Graversen *et al.*, 2002; Kalpazidou Schmidt *et al.*, 2002).

On consultation with the relevant Research Councils, The Danish Council for Research Policy selected and proposed 15 research environments at Danish universities and other public-sector research institutes to be included in the survey. Those selected encompassed university departments, research centres, networks and public-sector research units, from multiple faculties, and engaged in basic as well as in applied research. Selection was made in order to map out the characteristics of dynamic and innovative research environments throughout the country. The Council suggested the 15 units as examples of innovative and dynamic research environments based on their evaluation in connection with other advisory work.

For obvious reasons, those selected comprised only a part of the dynamic and innovative research environments in Denmark. The results of the survey reveal the characteristics of the Danish research environments and reflect the Danish framework for research. It seems, however, in the light of literature in the field and in comparison to other studies of

Evanthia Kalpazidou Schmidt is a senior researcher at AFSK. She received her PhD from Uppsala University, Sweden. Her main fields of interest are sociology of science, research environments and production of knowledge, organisational efficiency and productivity. Her most recent work focuses on research policy and evaluation of research in a European context. Her latest publication is connected to the activities of The European RTD Evaluation Network established by DG Research, The European Commission.

Ebbe Krogh Graversen is a research director at AFSK and received his PhD from The University of Aarhus, Denmark. His main fields of interest are measures and indicators on R&D, innovation capacity and the knowledge economy, innovation and growth, industrial and labour economics. He is affiliated to The European Network on Human Mobility, The Nordic Human Capital Group and The Focus Group on Human Capital Mobility (OECD).

Kamma Langberg is a senior researcher at AFSK. She received her PhD from The Aarhus School of Business, Denmark. Her main fields of interest are informal economics, research management and conditions, and statistical analyses. Her latest work focuses on leadership and research management under rapid change, a project with a multi-disciplinary approach.

research environments and research cultures in the UK, the USA and countries in Scandinavia (Becher, 1985; 1989; Kalpazidou Schmidt, 1996; 2002), that the findings may not be specific to a small country like Denmark.

The studied environments demonstrate an intensive interaction with other international research environments. Several were highly inspired from milieus abroad (that functioned as prototypes with respect to the organisation and management of research). Hence it is likely that the findings correspond to the way innovative and dynamic research environments function in western societies, particularly in Europe.

The main objective of the study was to identify characteristics of dynamic and innovative research environments to highlight them as examples for good practice. The study, however, aimed to explore influences that developed innovative and dynamic research environments in Denmark, and how factors within research environments as well as in the broader environment, such as research policy, influenced organisational structures, research activities and outcomes. The survey included a variety of elements within the research environments: input; structures; funding; physical and social environment; research processes; and communication patterns and networks in relation to external influences.

Point of reference

In the literature, two distinct perspectives have developed on the way research is influenced and controlled. One is the internalist perspective, which outlines the development of research as determined by structures and processes within the scientific community. The other is the externalist perspective,

which perceives research development as influenced by structures and processes in society as a whole. Within these two perspectives, there exists a variety of different theories, which differ with respect to the mechanisms of control and influence that they consider important.²

The internalist perspective in general is often criticised for its narrow focus on factors internal to the research community. In this approach, external factors influencing research are not subject to analysis, which again implies that the internalist perspective contains only a few dimensions of the overall process.

The externalist perspective is more open and complex than the internalist. It is thereby more equivocal. Within this perspective, different theories exist that as a common feature see the development of research in the context within which it operates (see also Gibbons *et al*, 1994; Nowotny *et al*, 2000).

The two approaches, far from opposing each other, must be considered as complementary. The analysis presented in this article seeks to combine the two perspectives and focus on the complementarities of these as the Model for Studies of Research Environments used in the study also illustrates (see Figure 1). Focusing on the interaction between internal and external factors has given a better understanding of the complex mechanisms of innovation and dynamics in research environments.

In this article, emphasis is given to the research-policy approach, which focuses on policy aspects and the influence of policy-making on research. The motive is to contribute to the debate on science policy-making and policy strategies in Denmark and Europe in general. In this sense, the article offers some suggestions for improving the overall ecology of research and knowledge production.

Research-policy perspective

In the span of only a few decades, the relationship between science and society has changed significantly. Science policy paradigms have changed accordingly. This issue has been addressed in a number of contributions to the field of science policy studies (Georghiou, 1998; Etzkowitz and Leydesdorff, 2000; Gibbons *et al*, 1994; Ziman, 1994; Guston, 2000; Nowotny *et al*, 2000). These contributions illustrate that the organisation of research, the functioning of research systems, and the design and management of science policy is changing rapidly and that increasing demands on performance are to be found on research systems in most European countries.³

The research-policy perspective sees research units as political organisations and the influence and control of research as being determined by contextual factors — policy-making amongst others. The external influence and impact depends on the degree of bureaucracy that policy-making bodies practice on research institutions. The arguments are, on the one hand, that a high degree of autonomy and

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Figure 1. A model for studies of research environments (MSRE)

freedom is the basis for research development and innovation, and that policy-making should have this as its point of departure, and on the other hand that research should be planned, organised and controlled by political means.

There are also strong arguments in the literature for a more differentiated research-policy perspective (see Cheng and McKinley, 1983; Foss Hansen, 1988; Mitroff, 1974). These point to the beneficial effects of having a differentiated policy depending on the discipline, the nature of research fields, and how clear and definable the research subjects in question are. According to this perception, research in some phases and within some disciplines could advantageously be the subject of external influence. The point of this approach is that the challenge is to create conditions for research diversity⁴ and ensure room for basic and innovative science.

A model for studies of research environments

As a reference for the survey 'Dynamics and Innovation in Universities and Public Sector Research Institutes in Denmark — an analysis of the characteristics of dynamic and innovative research environments' (Graversen *et al.*, 2002), a theoretical approach was chosen that seeks to combine the internalist and externalist perspective. The objective was further to analyse as many of the factors as possible that interact in and with research environments and influence research processes and activities (see Scott, 1981; Dahllöf, 1982; Dahllöf *et al.*, 1991;

Scharioth and Gizycki, 1986; Andersen and Foss Hansen, 1985–86; Clark, 1987; Foss Hansen, 1987; Kalpazidou Schmidt, 1996; 2002).

The Model for Studies of Research Environments (MSRE) was adopted for the analysis. This was first developed and tested in the 90s in connection with comparative studies of research environments in Scandinavia, and it then had to be modified to meet the requirements of the present study (Kalpazidou Schmidt, 1996).

The MSRE (Figure 1) focuses on the capacity, the organisation, the research activities and processes taking place within research environments, as well as on environmental conditions recorded outside the institutions that influence organisation and research processes. Conditions that are identified outside these units (such as socio-economic factors, research policies and the academic market) could have a direct or indirect influence on research activities and outcomes, as previous studies on research environments and literature on the production of knowledge reveal (Dahllöf, 1982; Gibbons *et al.*, 1994; Kalpazidou Schmidt, 1996; 2002, Jørgensen *et al.*, 1998; Nowotny *et al.*, 2000; Jacobsen *et al.*, 2001).

MSRE allows for the analysis of elements of input, structure, processes and outcomes. The study becomes more complicated compared to simpler input–output models, though with the benefit of being better able to capture the complexity of today's scientific world.

According to MSRE, a research organisation transforms an input (grants, competences, and

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qualifications of research) through a process to an outcome (dissertations, publications, postgraduate students, patents, rewards). Research is determined, however, by different processes in the research environment, such as research activities, communication patterns and networks, conditions for research, working climate, recruiting systems and advancement, education and socialisation of researchers.

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

Moreover, the MSRE focuses on the relationship between science and society and emphasises the influence of external factors on research. According to the model, external factors at a societal level constitute a framework for research activities. This relationship is characterised by interaction. This again implies that changes in conditions in the society as a whole have an influence on research and vice versa.

This approach is for the very same reason in line with the description of the changes in the new production of knowledge that the Mode 2 concept (in comparison to Mode 1) has introduced with respect to the constitution of science and research practices. Mode 2 illustrates the growing contextualisation and socialisation of knowledge. The implications of the argumentation in the Mode 2 concept (as in the MSRE approach) are that science and research can no longer be regarded as an autonomous space, demarcated from the rest of the society (Gibbons *et al*, 1994; Nowotny *et al*, 2000).

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 analysis presented here aims to give a better

knowledge of dynamic and innovation processes in research environments by illustrating the common characteristics of these and their frameworks.

The studied research environments represent all 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. The selected research environments only comprise a part of the dynamic and innovative environments in Denmark. The results though, taking into consideration the survey as an in-depth study of factors that characterise such units, and in the light of literature in the field, are likely to be relevant for research policy more generally.

The study is based on surveys carried out among researchers and research leaders of the environments in focus. A combination of qualitative and quantitative methods was adopted with in-depth semi-structured interviews with the leadership as well as questionnaires answered by the researchers. Moreover, data in the form of documents and research records were assembled from universities and research institutions.

The survey further encompassed the history and development of the research environments in question. The latter was done with respect to the origin and roots of the dominant research traditions and leadership styles, to uncover the way different personalities had influenced and shaped each research environment.

Dynamic and innovative research environments

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

- Clearly formulated research strategies and research objectives; strategic planning.
- Research strategies encompassing planning and co-ordination of activities, formulation of target areas and prioritisation of research areas and research projects.
- Distinct research profiles: researchers in such environments are predominantly engaged in research areas that are unique within Denmark in the sense that the object for their work in general is typically not in focus in other research environments in the country.
- Leadership and management focus on research activities, research quality and development of competencies.
- Leadership and management focus on organisational efficiency and productivity.

Furthermore, the results demonstrate that dynamic and innovative research environments have active, transparent and competent leadership based on modern personnel management styles. Leaders are active (not only as managers but also as researchers) 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 prototypes for dynamic and innovative environments in Denmark. Typically leaders are inspired by experience gained in foreign scientific environments through research visits and fellowship. Inspiration concerns, in particular, physical planning and the organisation of research. In many instances, inspiration from abroad influences cognitive processes as well; that is to say it influences the preference for, and the selection of, research fields and subjects.

It is evident that interaction with 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-recognised. Building on international networks is a decisive factor for the development of the Danish environments. Knowledge transfer in these environments is considered a precondition for dynamism and innovation.

The studied environments have excellent research frameworks and attract adequate financial support. They draw on substantial external resources, which contribute to their innovatory dynamism. In addition, external funding, coming either from the private or the public sector, stimulates teamwork and co-operation with other environments in Denmark and abroad.

External funding also reinforces inter-disciplinary initiatives and facilitates the process of recruitment of new researchers. An interesting observation made was that in most of the studied environments there was a dependency on the inflow of external resources. The level of research activity could evidently not be maintained without this type of funding.

Dynamic environments build on a flexible research organisation where internal co-operation, based mainly on specialised teams, has high priority. Dynamic and innovative environments also build on well-defined and transparent staff policies with the aim of encouraging and supporting contact creation, often in the form of networks, especially international ones. These initiatives set the framework for researchers' professional development.

Staff policies are based on the principle of research autonomy. However, the degree of 'professional freedom' generally speaking is higher during research processes and lower with respect to selection of research subjects. This is because the studied environments are characterised by distinct research profiles. This restrains, to some extent, the possibilities of working within a wider range of research areas. Even though this sets some limits on the research autonomy, dynamic and innovative environments are open for new initiatives within a defined framework.

The dynamic research environments have a clear recruitment policy that builds on a solid core of senior competences and on mobility, focusing on recruiting energetic, enthusiastic and committed researchers: the age difference between researchers is clearly promoting innovation

Dynamic and innovative environments strengthen the scientific élite, who ensure the quality of research and assist the younger researchers, both in the socialisation process and in relation to the different markets that constitute the context for research (such as publication and resources). The meritocratic system rewards well-performed research using different incentives and reward mechanisms. By using these mechanisms, the organisation aims to make research environments equally attractive to Danish and foreign researchers to ensure the dialogue and interaction with other units, and in doing so, to promote innovation.

In addition, the studied research environments have a clear and transparent recruitment policy that builds on a solid core of senior competences but also on mobility. The leadership focuses consequently on attracting younger researchers and recruiting energetic, enthusiastic and committed researchers. The age difference between researchers, which implies interaction between several generations housed under the same roof, is clearly promoting innovation. The study tells us that recruitment policy is a significant factor when seeking to promote innovation and dynamics in research environments.

The environments in focus are also characterised by a good working climate. The organisations base themselves on internalised norms and research traditions that are rooted in the history of the units. At the same time, a pluralistic approach prevails. This approach contributes to openness toward new ideas, methods and research traditions. Furthermore, an ongoing internal dialogue on research tasks, research theories and research methods is established. The internal dialogue and the openness to new ideas clearly promote innovation.

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 sensibility towards changes in the surrounding society. Dynamic environments consider it important to establish communication channels to society in broader terms and are thereby able to promote the interest of the research group in society.

Dynamic environments are also open and responsive to requests from society, including the private sector and the political establishment. It must be underlined, however, that this does not unequivocally imply that all research environments in focus have close co-operation with the private sector. Researchers in some of the environments are dealing with subjects that are of no immediate interest to the private sector.

Organisation of research

Dynamic and innovative research environments are organisations without clearly defined boundaries. They are open and 'fluid'. They comprise a core group of researchers, and a group of less closely connected colleagues with somewhat different research profiles. The innovative environments, consequently, do not in particular emphasise their outer boundaries in the organisation. Instead, they concentrate on defining internal factors such as norms and values in the environments. They focus on co-operation and quality. This policy becomes a predominant factor in the process of recruiting new researchers. Socialisation of young researchers in this connection is of significance for the development of the research unit.

The organisation structure in dynamic and innovative environments emphasises the importance of research leadership and the research group. This means that research groups and not individuals are favoured when it comes to the allocation of resources.

The point of attention in well-functioning research environments is strategic planning and definition of goals that primarily the leadership formulates. It is not always the case that all researchers (especially the younger) are acquainted with the common goals and aims defined by the leadership. The goals vary among the studied environments — some have overall goals, others very specifically formulated objectives. However, and as a rule, the leadership of dynamic and innovative research environments works on the basis of well-formulated strategies and priorities.

The reference for activities in the studied environments is usually requests and needs originating from the surrounding society. Research leaders combine societal needs with the professional interests of research groups. This evidently increases the potential for obtaining external funding from several different sources.

It has to be underlined though, that to a large extent dynamic research environments are dependent on external resources and have developed mechanisms and procedures that allow them to deal with funding issues. Moreover, the study of dynamic and innovative research environments reveals that conditions in their framework, such as the market for academic positions and for resources and research policy initiatives, are highly important with respect

to recruitment and funding, and ultimately for the very development of research in the units.

The informal structure of dynamic and innovative research environments — factors such as dialogue and communication, network building, internalised norms, values and traditions — influence to a large extent the content of research activities, and the quality, international visibility and productivity of the research units. The demography and staff composition of the units, with different personalities interacting within a specified framework, play an important part in the organisation of research and the research process itself.

The organisations of the studied environments emphasise communication with international research and facilitate international network building. Reference groups and potential networks are largely to be found internationally as the high degree of research specialisations also implies. Dialogue partners may be found in the international arena.

Leadership and management

It is apparent that leaders of the studied units are respected researchers themselves. They have developed leadership competencies over time and hence have a considerable impact on their colleagues. Leaders of innovative and dynamic environments have excellent possibilities for influencing and changing research environments and have usually been instrumental in shaping the one in which they work.

Leaders represented in this survey consider it essential to have clearly formulated research strategies and well-defined research goals. These goals vary among environments with respect to the level of aggregation — some are overall, others are more specific.

Leaders also map out the research framework and the research environment. They take an active part in securing the resources, prioritising the research tasks, formulating target areas and co-ordinating activities.

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, leaders attempt to promote dialogue and communication, are open to new ideas and traditions, and try to form a well-functioning social environment. They are actively engaged in identifying and recruiting energetic, enthusiastic and committed researchers.

Leaders pay attention to the quality of research, quality assurance and international co-operation. Managers regard the last point as particularly important with respect to young researchers' professional development. Managers of research environments from the social sciences and humanities taking part in the study stressed above all the need to focus on research and not only on teaching, as it is the case at many universities.

Leaders take every opportunity to emphasise the significance of the work of their colleagues internationally, in connection with contacts to the private sector and to society as a whole. These issues are considered by the leadership as being of significance for the dynamism and general development of research environments.

The study also points to the fact that leaders have the opportunity to influence research policy through their research work, as their research activities are unique to the country. Through participation in different advisory committees and research councils this mode of influence is utilised for promotion of research fields and environments.

In conclusion, research leaders of dynamic and innovative research environments perceive their role in a remarkably similar way when it comes to decision-making and use similar strategies and instrumentation to promote dynamics and innovation in the environment.

Conclusion: perspectives for research policy

Although research leaders act similarly when promoting innovation, the results of the empirical study show, given the wide range of the studied institutions and units, great differentiation and diversity. The differentiation depends on factors internal to the units, such as organisation and structure, research cultures and research traditions, research profiles and specialisations, communication patterns, networks and community life. It also depends on context-related socio-economic determined factors external to the units, such as research policy, national needs and priorities.

Research environments are complex organisations. Simple input-output approaches are not appropriate when studying research processes and innovation. Research activities have different needs, and take place in different environments and within multiple, differentiated frameworks. The survey reveals that studies of research environments are better served by a combination of an internalist and externalist approach. The analysis of the mechanisms that shape environmental conditions for research processes and outcomes could be an effective instrument in the effort to create well-functioning, innovative and productive research ecologies.

One main conclusion is the importance of the organisation and the management of research environments for innovation and dynamics. This consequently has clear implications for research policies.

Implications for research policy

With respect to the research ecology, the analysis demonstrates that what actually characterises dynamic and innovative research environments is diversity. Research has differentiated needs, is carried out under

different conditions and within different frameworks. The survey also demonstrates that within dynamic environments there are common features and similarities regarding organisation and management, recruiting and personnel policy, working environment, communication patterns and financing.

The survey demonstrates that creating and developing dynamic and innovative research environments takes time and requires a continuous inflow of resources. Research into research conditions and frameworks has to be intensified in order to reinforce the dynamism in the environments. As to the immediate implications for research policy, the analysis presented in this article can be used as an instrument to form the ecology, that is, the framework for research activities. Accordingly, the following three issues are important for research policy-making: the organisation and leadership of research environments; the framework and the conditions for research; and the resource allocation policy.

Organisation, management and leadership

The survey illustrates that strategic planning, organisation and management of research and co-ordination of activities are characteristic of the environments in focus. The existence of these factors in the units is not counterproductive to the autonomy of the environments and does not put limitations on the independence of researchers, particularly 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.

However, in some disciplines and fields and as a consequence of the subject-specific characteristics, the effect of strategic planning and organisation may be stronger than in others. The degree of control and management of research must be differentiated depending on how well the research subject is definable and also on the degree of consensus among scientists regarding the application of methods and approaches in a certain process.

Organisation and management of universities and other research institutions must be flexible and give room for a broad operational canvas to research

Organisation and management of universities and other research institutions must be flexible and give room for a broad operational canvas to research leaders, managers and researchers: this should be backed up by intensive communication and dialogue on several levels

leaders, managers and researchers. This should be underpinned by intensive communication and dialogue on several levels, both internally in and between the units and the overall organisation of universities and also externally, for instance, between the research environments and other societal agents.

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

Research policy has to focus moreover on the co-operation between university research, other public research and the private sector. It is important to ensure that the private sector is sufficiently informed about options and perspectives for co-operation with university and other public-sector research. Tangible incentives for co-operation could be considered. Policy-making bodies could increase efforts finding out how to make better use of the results of public research in the attempt to achieve the knowledge-based society.

Research-policy bodies have to consider that not all research is of immediate use to society, nor can it always directly match the societal requirements or the needs of the private sector. In the process of allocation of resources it is crucial to pay attention to research environments that focus on basic research too, to limit the risk of overlooking potential innovative research.

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

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 approach to take in the effort to promote innovative research.

Development of the organisation at the 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 demonstrate, either successfully

created or adapted their framework to be a stimulating leadership tool promoting innovation.

A precondition for innovative research environments, when developing frameworks, is the local knowledge of research conditions and requirements. Leaders of research environments are in possession of this knowledge and, as respected scientists, are able to make use of their authority to implement decisions. Research leaders should be given the necessary management tools that enable them to make decisions and implement new initiatives locally.

Research leaders may also have the necessary time and space to act as efficient leaders when focusing on research strategies and implementations. Upgrading management skills could be considered as a significant option and an incorporated component of the development of research organisations. The role of research leaders at the unit level should be upgraded in the dynamic process of knowledge production.

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

Allocation of resources

With regard to allocation of resources, there is a need to differentiate the use of instruments such as funding mechanisms and arrangements between the 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, especially in the humanities and the social sciences, basic governmental funding is a necessary precondition for building up research environments which could ultimately attract external funding.

External funding is often time limited and 'impatient', implying that this form of funding assumes that 'milestone' results are already achieved. Before research areas with great uncertainty can benefit from external funding, research environments need basic governmental funding to explore new research areas, consolidate their positions and secure continuity in activities. It is obvious that successful external funding requires that a high quality research environment has already been established. 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 should receive different treatment in policy-making from areas that are not yet firmly rooted. Research policies should prioritise research fields in the former area, while the latter should be allowed considerably more space and freedom, both in terms of selecting research

subjects and in funding and expectations of immediate efficiency. It could, however, be difficult for policy-makers to make judgments on the position of disciplines, especially in the social sciences and humanities. At this point, the research councils could provide the necessary tools for decision-making.

As a step in a decentralisation process, research environments could be given greater scope for introducing varying types of incentives at research-group level and access to direct and indirect remuneration systems to support and strengthen selected research areas.

Concluding remarks

The study of innovation and dynamics in public research in Denmark identifies the elements that are of importance to the development of such environments. The study demonstrates that the characteristics of dynamic and innovative research environments originate both from factors internal to the units and also from context-related factors external to the organisation and the processes taking place in the units. External factors working directly or indirectly have a significant impact on research. This highlights the importance of policy-making for the framework of research, the research process and the outcomes.

In conclusion, and considering the international orientation of the research environments that participated in the survey, it is likely that the analysis of what characterises dynamic and innovative research environments is relevant to the debate on research and science policy in other countries as well.

Notes

1. For detailed presentation of the Danish research council system see Foss Hansen (1996), Benner and Sandström (2000) and Bertilsson (2001).
2. For a presentation of the different perspectives see Foss Hansen (1988).
3. For a more explicit presentation of the latest development in 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).
4. For a detailed discussion of the concept of diversity and its implications for innovative knowledge processes see Metcalfe (2000; 2001) and Ramlogan and Metcalfe (2001).

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