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The impact of regionalised RTDI policy measures in Germany: The "Network RNA Technologies Berlin (RiNA)" as an example

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Abstract

Taking the most popular regional RTDI policy concepts, particularly the "network paradigm" (Cooke/Morgan 1993) as a starting point, it is the objective of this paper to theoretically and empirically discuss the necessity and impact of regional or regionalised RTDI policy measures within the context of multi-level governance. Based on the promotional measure "Netzwerk RNA-Technologien Berlin", initiated by the German Ministry of Education and Research (BMBF), we shall discuss what kinds of specific policy measures can be undertaken in order to activate and support regionally embedded scientific-technological potentials. In addition, attention will be paid to challenges regarding the multi-level governance of the funding measure and regional and national effects, particularly within the context of research and networks aspects. What can be seen from the case study is that the coordination of the funding measure proved to be quite challenging. Due to the long-lasting and complicated process of setting up the funding measure and the implicit, diverging goals and interests of the key players BMBF, Senate and industry, the resulting network is characterised by unique structural elements which are intertwined or overlap with each other in complex ways. However, due to the policy measure – which supports network activities primarily within cooperation projects –, the cooperation intensity of scientific institutions with companies was increased significantly, thus contributing to the goal of fostering the commercial exploitation of research results.

1 Introduction

The regional role of research, technological development and particularly innovation has, not surprisingly, important implications for policy-making. Attempts at stimulating the development of certain technologies and innovation have been undertaken almost everywhere in the world, often with an explicit emphasis on regional networks and clusters (Rosiello/Orsenigo 2008). Germany is no exception, as the federal government in the mid-1990s discovered the regional level as a new reference unit for technology and innovation policy (Dohse 2007). Policy measures such as the BioRegio contest, EXIST – university-based start-ups or the InnoRegio contest for eastern Germany are the most popular examples which have attracted a great deal of attention nationally as well as internationally. All these initiatives (and many more that have been implemented by the federal government and also regional governments) have in common, that regional production factors are made the basis for regional and innovation promotion (Koschatzky 1997: 185-187) and that regions compete against each other in order to obtain national funds.

The role of regions is not a passive one. Regions have become active players in the innovation process rather than being solely recipients of public funding (Dohse 2007). As regards the aforementioned initiatives, regions have to be creative to be successful in the competition for public funding. "Strategic intelligence" is needed to bundle and activate their technological and innovative resources and to establish modes of self-organisation. In general, the rationale behind regional or regionalised RTDI policy is that policies explicitly consider the existing spatial structure of a country and try to exploit the propensity of technology- and knowledge-intensive industries to cluster in order to raise regional or national competitiveness (Sternberg 2003). Within this context, it is increasingly recognized that the competitiveness of regions and countries seems related to the capability to generate new ideas and use them to innovate. Thus, according to Koschatzky and Gundrum (1997: 212) public regional innovation and technology promotion – which often goes hand in hand with initiating or supporting networks, referring to regional research and innovation systems or technology-based clusters – therefore has three tasks:

- the activation and careful complementing of regional resources for the development and application of new technologies (regional innovation conditions),
- the co-ordination and interlinking of these resources in regional innovation networks, bringing in all the relevant actors in industry, science and policy,
- the integration of these regional networks into national and international clusters of technology development and production, through the creation of active interfaces and the promotion of supra-regional co-operation.

In line with these tasks, the network idea or the "network paradigm" (Cooke/Morgan 1993) and possibilities for making use of spatial and cultural proximity between firms and supporting institutions is considered crucial. While in the years before the network idea was at least also implicitly applied in public promotion measures and innovation supporting services (e.g. in the Steinbeis technology transfer concept, or in the promotion of joint research projects between firms or between firms and research institutes), this paradigm – in the form of the creation of regional research and innovation systems - is now made explicitly in innovation and technology policy (Koschatzky 2001: 10).

Taking the network paradigm as a starting point for the design and implementation of regional or regionalised RTDI policy measures, it is the objective of this paper to theoretically and empirically discuss the necessity and impact of regional or regionalised RTDI policy measures within the context of multi-level governance. Based on a German case study we shall discuss which policy measure has been implemented to establish a national competence centre in a certain technology field and which conclu-

sions can be drawn regarding the adaptation of the measure to changing framework conditions and the devolution to similar regions with specific location factors.[1]

2 Regional RTDI policy concepts

Regional policy strategies and concepts discuss possibilities and opportunities of the (concentrated) implementation of policy instruments and measures towards certain locations. According to Kulke (2004), such strategies are more than the adoption of policy instruments in microeconomic activities. In fact, they constitute a bundle of measures aiming at one or more policy goals (e.g. raise the employment of a region, the competitiveness or the technological capability). In parallel, incentives for the settling of private economic activities are implemented, the construction of the physical and institutional infrastructure as well as transport and communication networks are established. With a view to regional RTDI policy measures, the funding of research institutes, technology transfer centres, single-firm R&D and innovation funding, joint research activities as well as networks, cluster-related measures and the support of regional innovations systems are the most popular approaches.

The intervention of the government in technological development and innovation – be it on a regional or national level – is not indisputable (Dreher 1997: 26-31). The "market failure" rationales in RTDI policy are dominant for neoclassical welfare economics as a meta-rationale for government action and inaction (Laranja et al. 2008). Despite alternative perspectives such as "learning failure", for example, the dominant discourse of public policy intervention in all policy spheres continues to be very much framed by the view that policy intervention is justified only in circumstances where markets clearly fail to allocate resources so as to optimise overall social welfare (Howlett/Ramesh 1993). According to Laranja et al. (2008), typical policies associated with the market failure rationale are those directed at compensating for market failures in the less than optimal allocation of private resources to science and those oriented towards the diffusion and transfer of technology-information.

Another rationale for regional RTDI policy can be derived from the so-called systemic institutional approach to innovation. These systemic institutional approaches accept that beneficial externalities are created because of the non-rival nature of technology.

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1 The empirical part of the paper is based on the ex-post evaluation of the "Network RNA Technologies Berlin (RiNA)", a policy measure jointly funded and implemented by the Federal Ministry of Education and Research (BMBF) and the Senate of Berlin in the period of 1998-2007. The evaluation was commissioned by the BMBF and carried out by Fraunhofer ISI in 2006-2007.

But these approaches are seen as being specific to the institutional context that promotes and shapes the learning interactions. These approaches have latterly taken a regional turn, emphasising the importance of "institutional thickness" and governance structures underpinning regional innovation "systems" or "networks" (Amin 1999; Cooke et al. 1997).

The concept of regional systems of innovation was first developed by Cooke (1992). A regional innovation system can be understood as a concentration of interacting private and public organisations, formal institutions, and other organisations that function according to organisational and institutional arrangements and relationships conducive to the generation, use and dissemination of knowledge (Doloreux 2004). According to Asheim and Coenen (2005), it consists of a knowledge and institutional infrastructure supporting innovation within the industrial structure of a region. Regional systems are not national systems in miniature, but respond to different rationales, institutional and governance settings which can be found at the sub-national territorial level. It is a distinct element of the concept that a region does not offer all factors and institutions necessary for innovation, but that it is a part of a superior, i.e. national system, and has to cooperate with other regional or national systems in order to merge all necessary resources at the specific territory (Asheim/Gertler 2005; Cooke et al. 2004).

An important part of the (regional) innovation system is the research system which overlaps with the former to a certain extent, but comprises research aspects which do not have direct impacts on innovation activities. Since research creates new knowledge and improves the already existing scientific knowledge base, the knowledge derived by research activities is an important input in innovation activities. Nevertheless, new knowledge is also created during the innovation process. This knowledge can be specific (and sometimes tacit) and confined to those individuals or organisations which are involved in the knowledge generation process, or it can be of non-specific character, become codified and enrich the general knowledge base.

The approach of the regional innovation (and research) system emphasises the dynamic, cumulative and social nature of the innovation (and research) process and the network of relationships between the structure of production and the institutional setting in which they are embedded (Asheim/Gertler 2005). Like the concept of the innovative regional milieux (Maillat/Lecoq 1992), a regional innovation system consists of formal and informal networks featuring mutual economic and technological interdependencies. Schätzl (2003) points to the following constitutional characteristics of such networks:

- Formal, informal and social contacts between many regional actors (firms, labour force, clients, and institutions) allow for network action, encourage collective learn-

ing and reduce uncertainties in the course of technological change; this may result in the solving of problems, synergies as well as the reduction of transaction costs.

- Regional delineation of networks: crucial for the innovation dynamic is the spatial proximity of the different actors; "face-to-face" contacts, the mobilisation of intraregional human capital, trustful cooperation between mostly small and medium-sized enterprises, flexible supply chains, an innovation-oriented cooperation of business and policy, etc. require regional networks.

In general, the concept of regional innovation systems and the network approach (as well as many other national and regional concepts, see for example the cluster approach) stresses the importance of learning in the innovation process and underline the specific character of tacit knowledge and its implications for spatial proximity and the necessity of being embedded in certain spatial contexts for technological development and innovation (Mackinnon 2002). However, whether a regional(-ised) research and innovation policy could be effective depends very much on the concrete policy concept, but also on the ability of the policy-makers to coordinate RTDI policy, especially against the background of a multitude of governance mechanisms and layers that subsist in countries with a federal constitution.

3 Coordination of regional RTDI policy

As already pointed out, policy measures implemented at the regional level have gained in importance, particularly as regards RTDI policy. According to Koschatzky and Kroll (2007), top-down policy design – in many European countries – has been replaced by bargaining and substantial regional autonomy; regional interests and pre-conditions for policy measures are taken more and more seriously. In consequence, policy coordination in the form of multi-level and multi-actor governance has become an essential issue in many countries and regions. For Cooke (2002), the term governance is the key to the theoretical discussion about the importance of the role that policy and politics play for innovation systems. Fürst (2001) defines regional governance as weakly institutionalised, network-oriented modes of cooperation between regional actors to achieve common goals of regional development. Referring to technology and innovation policy, important goals could be an increase of R&D activities of the industry sector, the exploitation of technological and innovation potentials or an increase of the amount of (innovative) start-up companies. Relevant regional actors could be, for example, universities, technology-oriented enterprises, knowledge-intensive business service firms (KIBS), regional government or administration, project management organisations, intermediaries (e.g. technology transfer offices, venture capital firms) or non-university research institutes.

The term "multi-level governance" refers to actors on the different policy or administrative levels. Particularly EU funding activities or national RTDI policy initiatives implemented at the regional level are often characterised by a mix of quite complex financing mechanisms (co-financing). As for RTDI policy, regional multi-level and multi-actor governance often go hand in hand as some of the most popular funding schemes designed by national governments as well as the EU focus on innovations networks which a priori involve various actors. It is also important to note that, from the regional viewpoint, it is far more necessary in RTDI promotion to interact with other policy fields and administrative levels for which the regional administration is not responsible. This is one example of the so-called multi-level governance in which lower authorities have to coordinate their action with upper policy levels.

The need for improved policy coordination between the regional, national and European level especially in fields like RTDI has been accentuated by many authors (Fürst 2001; Koschatzky/Kroll 2007; Kuhlmann/Edler 2003). However, extensive research is still necessary to find out more about the mechanisms and impacts of different RTDI policy instruments under specific regional conditions. Institutional, technological and political regional path dependencies may result in barriers to (radical) innovation. As a matter of fact, neither does an ideal model of regional RTDI policy exist (Isaksen 2003; Tödtling/Trippl 2005), nor is it adequate to expect that good practices can be replicated without any adjustments.

4 RTDI policy learning

Public RTDI policy in Germany as well as in many other countries has become an important arena for supporting the techno-economic change, for increasing the national (and regional) competitiveness and for modernizing the economy (Kuhlmann/Meyer-Krahmer 1995). Since public budgets are becoming tighter, control requirements of the parliaments as well as the Commission of the European Union larger, the need for policy administrators to learn by implementing and designing RTDI policy instruments has resulted in new approaches to evaluate these instruments and policy programmes, Furthermore, a certain "creativity" of the administration to adapt specific elements of already implemented funding measures to the respective basic conditions of a different region or country can be observed. On the other hand, it can also be observed that evaluators themselves are more and more fulfilling a formative function (Kuhlmann 2004) in terms that promotional measures are utilised as a "learning medium", in which findings about cause and effect linking of running or completed measures can be utilised as intelligent information for current or future initiatives.

For Howlett and Ramesh (1993) "…policy learning is in effect learning about instruments". The relationships between actor and activator of learning is presented by Bandelow (2003), who distinguishes three different types of learning: advancement learning, like government learning and lesson-drawing is based on a normative learning term that connects learning of policy-makers with an increase of efficiency and effectiveness within the framework of distinct policies. An advisory relation is a major feature of such policies. In contrast, the practical benefit of the second learning type is less obvious: the conception of learning within the process of change, like political-learning and policy-oriented learning, focuses less on the improvement of practical policy rather than on the improved illustration of policy change. The third type of learning-theoretical approaches finally appears to be interesting as regards the issues of policy instruments (collective learning in public policy and strategic learning). This approach combines the practicability demand of the sociological organisational research with a learning term that "contains changes with decision structures of policy organisations, changes of norms and objectives of policy-makers as well as improvements regarding strategies of policy-makers to attain given norms and objectives" (Bandelow 2003).

Within the context of the different learning-theoretical approaches, the regional and national effects of RTDI policy measures are crucial, as the impact of such policies has an effect on the concrete policy instruments, the underlying strategies and ultimately the policy organisations. One of the most important tools linked to such impacts is evaluation. Kuhlmann (2004) suggests conceptualising evaluation as "strategic intelligence" in terms that a set of sources of information and explorative as well as analytical (theoretical, heuristic, methodological) tools have to be employed to produce useful insight in the actual or potential costs and effects of public policy and management. Evaluation can be used for different purposes. In the first instance, it can serve to measure performance and thus provide the legitimisation for promotional measures afterwards ("summative evaluation"), or it can be utilised as a learning tool in such a way that intelligent information for current or future actions is gained via evaluation (Kuhlmann 2004). According to Koschatzky (2005), this "formative" function of evaluation supports learning processes best, because it is often interactive and includes participative, negotiation-based processes in which all relevant actors can participate and intervene.

5 Conclusions and starting point for an empirical analysis

In the theoretical section it was discussed that the regional level has become the starting point for policy measures aiming at the better exploitation of research, technology and innovation potentials. The most popular regional policy concepts – particularly the regional research and innovation systems approach and the network approach – stress the importance of learning in the innovation process and underline the importance of network building as a possibility for making use of spatial and cultural proximity between firms, research institutes and intermediaries. Nevertheless, whether a regional(-ised) research and innovation policy could be effective still needs to be debated. In addition, the policy coordination between the regional, national and European level (multi-level governance) which also could impact on regional development has to be better understood in terms of the design of policies and mechanisms under specific regional conditions.

Against this background and on the basis of the project "Network RNA Technologies Berlin (RiNA)" as an example for a funding measure to support the creation of a regional research and innovation system in RNA technologies, the empirical part of the paper will focus on the following research questions:

- What kind of policy measures can be taken in order to activate and support scientific-technological developments under given regional framework conditions?
- Which are the major challenges encountered regarding the multi-level governance of a funding measure like the RiNA network?
- What regional and national effects do such funding measures have, especially with a view to "designing" a regional research and innovation network?
- What are the major conclusions regarding the further improvement of the funding measure and which implications can be deduced for other regions with similar technology starting conditions?

The next chapter is devoted to these research questions.

6 Case study: The funding measure "Network RNA Technologies Berlin"

6.1 Introduction to RNA technologies and their significance

RNA[2] technologies are an emerging field within the life sciences and biotechnology. For decades, research into RNA molecules has been a minor and rather exotic research field. From the mid 1990s onward, scientific evidence emerged that RNA molecules could have hitherto unknown, but biologically most important functions. When these groundbreaking findings Fire et al. (1998) were awarded the Nobel prize for Medicine in 2006 (Abbott 2006), the significant potential that RNA research has to offer became evident: in addition to new avenues in basic research and the generation of fundamental knowledge in the life sciences, the technological exploitation of RNA molecule functions offers the promise to develop and commercialise new RNA-based or RNA-targeted research tools in the life sciences, as well as diagnostic tests and analytical devices, and innovative pharmaceuticals (Hoffmann 2007; Howard 2003; Kalavrizioti et al. 2006; Mack 2007).

6.2 What kind of policy measures can be taken? – History, design and goals of the funding measure

During the BioRegio competition (1995), a regional strength in RNA research was identified by the Berlin-Brandenburg region, while at the same time first concepts for the foundation of an RNA research institute were developed by a leading German scientist in RNA research (champion), located in Berlin. As, however, the foundation of an institute turned out to be politically not possible at that time, the idea of funding a "virtual institute" in the form of a research network devoted to RNA research was pursued further. This resulted in the funding measure "Network RNA Technologies Berlin", implemented in 1998, and jointly funded by the Federal Ministry of Education and Research, the Senate of Berlin and industry with a total budget of € 47 m for a 10 year period from 1998-2007. This research and technology transfer network was initiated by and constructed around the RNA research champion located in Berlin.

With the aim of establishing a national competence and technology transfer centre for RNA technologies in Berlin, the network should serve as a focal point in the establishment of RNA technologies in Germany, lay the foundations for the application of RNA

2 RNA = Ribonucleic acid.

technologies in medicine and industry, as well as make a significant contribution to the education/training of junior scientists in the field of RNA technologies. Despite the infant stage of RNA research, the network's mission was to carry out applied RNA research, to bring research findings to commercialisation and to achieve sustainable funding within a decade of public funding. The funding measure was modelled along the lines of the gene centres. The inclusion of industry reflected at the same time the mission to conduct application-oriented research as the main focus. When forming the network it was also assumed that it would be possible, within the promotional period of ten years, to develop technologies, services and/or products mature enough for the market to an extent that the Netzwerk RNA-Technologien Berlin would subsequently be in a position to co-finance itself sustainably from the resulting revenues (e. g. product sales/ turnover, licensing fees, contract research respectively research services). The amount of this self-financing share was neither determined nor put in concrete terms.

The promotional measure Netzwerk RNA-Technologien Berlin at the time of launching represented the first large-scale, thematically very comprehensive and in addition application-research-oriented promotional measure in the field of RNA technologies, also by international comparison. No comparable promotional programme could be identified on the international scene. In the international promotional landscape, promotional measures explicitly directed towards RNA technologies are rather the exception, as in most countries primarily individual projects are promoted. Internationally speaking, the focus is rather placed on basic research.

6.3 Implications for the evaluation design

From the evaluator's viewpoint, the funding measure and the goals of the evaluation posed specific challenges, as the funding measure had to be assessed with respect to scientific excellence, technology transfer, commercialisation and economic impacts and (regional) network structures. Moreover, the client also requested recommendations for a comprehensive future funding strategy for RNA technologies in Germany. As a consequence, the evaluation design comprised the entire toolbox of programme and institutional evaluation for the RNA network, and the results obtained in the regional context were put into perspective with national and international performance and trends. The following quantitative and qualitative methods were employed:

- document analysis,
- written survey and social network analysis among network members and unsuccessful applicants for network membership,
- interviews with network members, and international RNA experts,

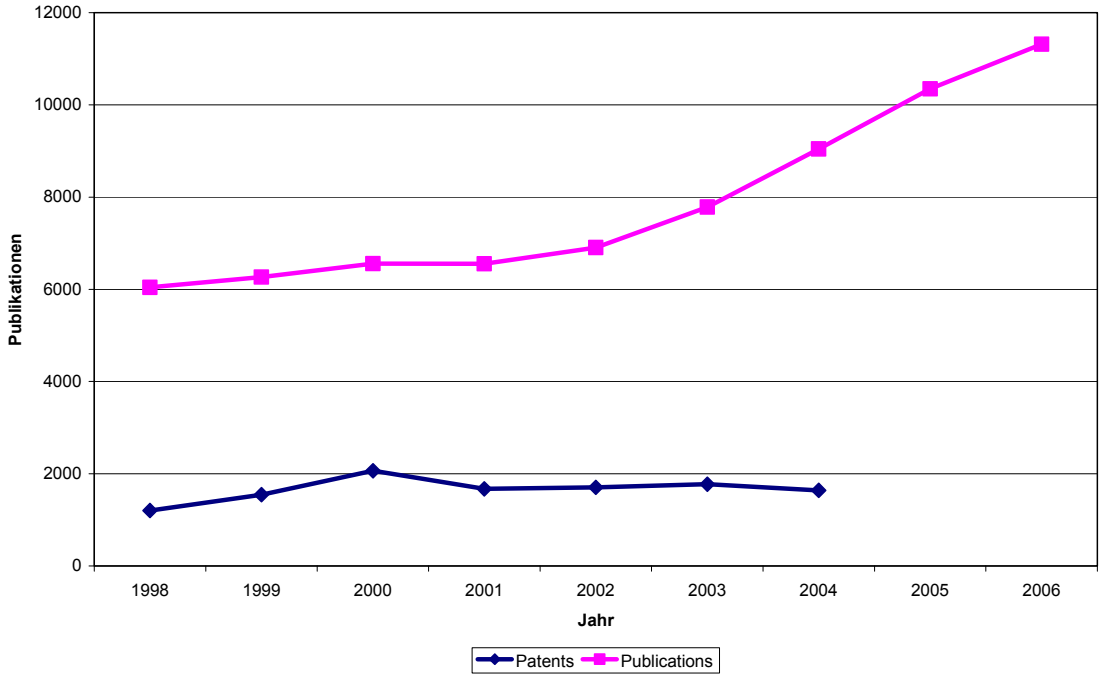
- a peer review assessment of the scientific and technology transfer achievements of the network,
- a comparison with reference networks with respect to network management, strategy and acquisition of sustainable funding of network activities during an expert hearing,
- bibliometric and patent statistical analyses,
- RNA technologies market analysis,
- analysis of international funding measures for RNA research and technologies.

6.4 Assessment of the appropriateness of the chosen approach in view of the goals, starting conditions and underlying assumptions

The assumptions underlying the establishment of the "Network RNA Technologies Berlin" could be corroborated: RNA technologies are a scientifically rewarding research field with substantial technological and economic potential. Indicators are the increase of publications and patent applications worldwide (figure 1) with growth rates above average, the significant increase in public funding during the last decades, both nationally and internationally (table 1, figure 2), the increasing number of RNA companies[3] and the strong increase in (financial) investment of pharmaceutical companies in this field, and first products on the market. The award of the Noble Prize for Medicine for the discovery of RNA interference in 2006 also underlines the significance of the field for the life sciences. Against this background, the establishment of the funding measure "Network RNA Technologies Berlin" appears forward-looking and strategically well chosen. In the international funding context, the measure is unique in its central characteristics (thematically comprehensive; combination of basic, application-oriented and clinical research; research and technology transfer network) and can be seen as a pioneering and cutting-edge measure in the RNA field.

3 At present there are approx. 100 enterprises worldwide which are commercially engaged in the field of RNA technologies. These are for the most part biotechnology firms dedicated to the development and production of research tools on an RNA basis, as well as research-active pharmaceutical companies and dedicated biotechnology companies that utilise the regulatory functions of RNA as a tool in the discovery and development process of new pharmaceuticals.

Figure 1: Annual publications and patent applications in RNA technologies worldwide; 1998-2004



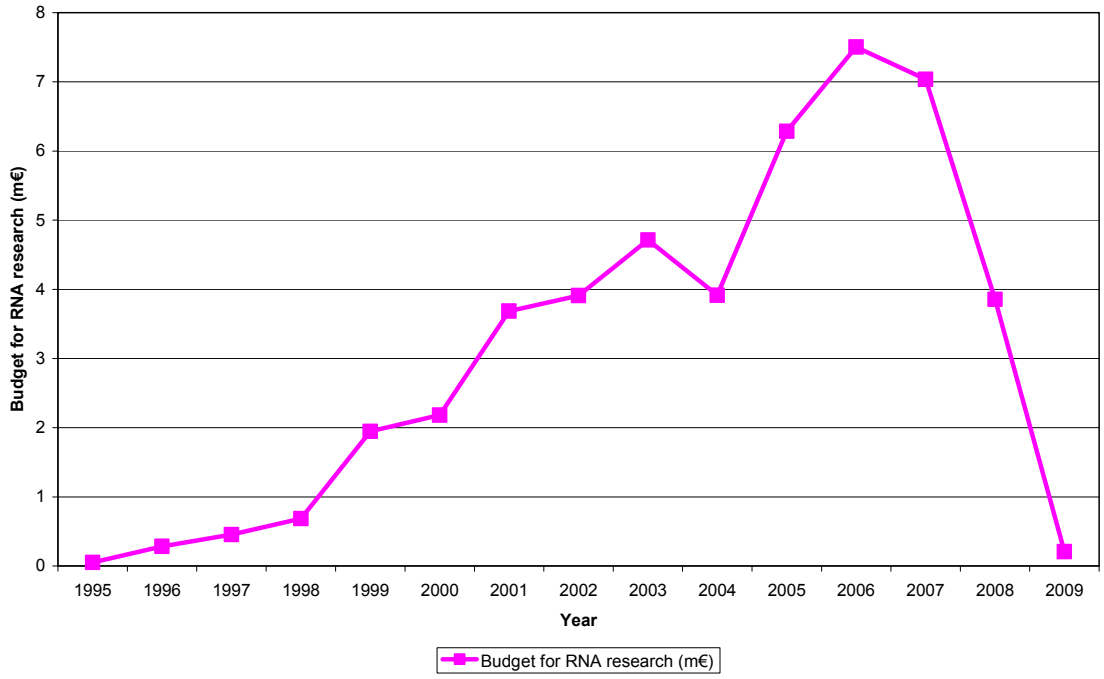
Source: Fraunhofer ISI search 2007; data: SCI, Thomson Scientific (publications); WPINDEX, Thomson Scientific (patents); search at host STN

Table 1: Budget for RNA research in the 5th and 6th EU framework research programmes

	EU FRP 5 (1998-2002)	EU FRP 6 (2002-2006)	Budget increase FRP5 → FRP 6
Budget (€) for RNA research	13,131,742	75,271,807	factor 4 (total budget increase factor 1.3)

Source: Fraunhofer ISI search 2007; CORDIS project database of the EC

Figure 2: Project funding by BMBF in RNA technologies (funding of network Berlin not included)



Source: Fraunhofer ISI search 2007; BMBF-Förderkatalog[4]

Within Germany, Berlin is one of four top locations with respect to the competencies and prerequisites to unfold the potential of RNA technologies. Therefore, the establishment of the Network RNA Technologies in Berlin is seen positively and strategically smart.

6.5 Impacts of the funding measure

6.5.1 Overview of impacts

Table 2 gives an overview of the overall positive and negative, intended and unintended impacts of the funding measure in the dimensions "Scientific excellence and competence", "Transfer" and "Network effects". In the following paragraphs, we will focus especially on the questions which network effects and additionalities have been achieved, and which challenges were encountered due to the multi-level governance in this funding measure.

4 http://oas2.ip.kp.dlr.de/foekat/foekat/foekat.

Table 2: Overview of impacts and degree of goal achievement of the funding measure

Intended/positive impacts; goals achieved	Unintended/negative impacts; goals not achieved
Scientific excellence and competence	
• Most scientific goals achieved; • Research of moderate to excellent quality and originality • Uptake of new hot research topics	• Lack of a peer review procedure according to international standards • Only average efforts to qualify junior scientists; sustainable establishment of junior scientist groups neither attempted nor achieved
Transfer	
• First products and services commercialised; • Progressive share of industrial funding of the network (30 → 40 %)	• Hardly any exploitation of alternative funding sources (e.g. DFG, EU framework programmes) • No business model developed which allows sustainable funding of network activities • Low number of jobs created, dependent on funding, not sustainably established
Network effects	
• Establishment of research projects and teams at the interface of academic, clinical and industrial research • Initiation and intensification of scientific cooperation and joint research between academic research and industry	• Only bilateral cooperation patterns prevail, linked to individual projects • Lack of development of a joint network research strategy and its implementation • Lack of development of a network identity both internally and externally; internationally not visible and perceived as a renowned RNA institution; reputation only linked to individual scientists • Knowledge generation and transfer largely confined to bilateral project teams

6.5.2 Network effects

The network showed a relatively stable core of members which remained constant over the 10 year funding period, which were complemented by members who joined or left the network and only participated for shorter periods of time. The network was especially successful in the inclusion of research groups with non-RNA competencies who through the participation in the network were put into the position to integrate RNA research into their (originally non-RNA-related) research focus. In this way, bridges between basic, applied and clinical research were established successfully. Internationally, the network is unique in its combination of academic, industrial and clinical research.

The network was successful in striking a good balance between thematic and organisational openness (avoiding lock-in effects) on the one hand, and loss of important competencies by fluctuation of network partners on the other hand. It remains a major challenge to maintain the open character of the network and to strengthen it further by the targeted acquisition of strategically important network partners. In this respect, the industry orientation on the one hand attracted new partners into the network, but at the same time deterred several outstanding scientists of high scientific reputation who would have strengthened the network scientifically from participating in the network.

Due to the promotional measure which funded primarily cooperation projects, the cooperation intensity of scientific institutions with companies was increased significantly (table 3), in this way contributing to the goal of fostering the commercial exploitation of research results. Approximately 50 % of network members established new cooperations, one quarter cooperated with new partners not known from previous activities.

Table 3: Impacts of network membership on cooperation behaviour

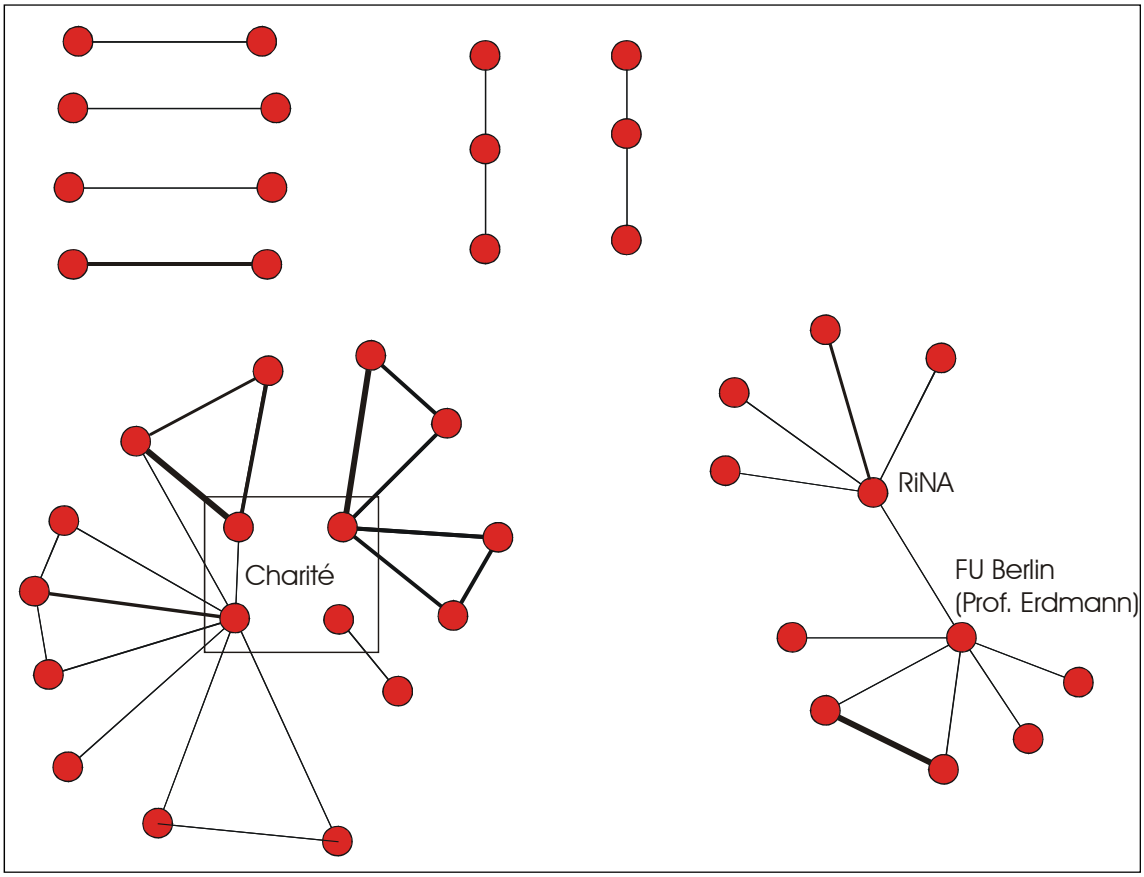
		N = 4	N = 12	N = 5
	Group	Industry	Scientists (proposal accepted)	Scientists (proposal rejected)
1	Before applying at RiNA, your cooperation with industry partners on RNA research was …	3.3	2.2	1.8
2	Today, your cooperation with industry partners on RNA research is...	3.3	3.8	2.0
3	Do you think this change (if any) is a result of your participation in RiNA?	3.0	4.6	
4	Are you planning to continue these cooperations (if any) during the next years?	5.0	4.7	
5	Before applying at RiNA, your cooperation with universities or other research institutes on RNA research was...	2.6	3.1	2.2
6	Today, your cooperation with universities or other research institutes on RNA research is...	3.4	3.8	2.8
7	Do you think this change (if any) is a result of your participation in RiNA?	3.6	4.0	
8	Are you planning to continue these cooperations (if any) during the next years?	3.8	4.8	

Legend line 1, 2, 5 und 6: 1 = not existent; 2 = hardly existent; 3 = average; 4 = intense; 5 = very intense. Legend line 3, 4, 7 und 8 und 7: 1 = not at all; 2 = hardly; 3 = partly; 4 = almost completely; 5 = completely.

Source: Fraunhofer ISI, written survey among network participants 2006-2007

However, most of the established cooperations are of bilateral character and involve only two or three network partners (figure 3). The development of joint research strategies beyond single cooperation projects has up to now been neglected, so that synergies between the network partners as a whole are exploited only sub-optimally. Moreover, a higher competence and reputation of the network could be achieved if the network were successful in attracting several internationally renowned research groups located in Berlin into the network.

Figure 3: Cooperation patterns between institutions in the Network RNA technologies Berlin



Source: Fraunhofer ISI analysis of the RNA network Berlin, 2007

6.5.3 Multi-level governance

The promotional measure "Network RNA-Technologies Berlin" is a joint action of the national funding body BMBF and the regional body of the Senate of Berlin. Moreover, industry is required to contribute to the overall funding. These funding actors had different intentions, goals, resources and influence on the governance in the network:

- Senate of Berlin: the Senate's aim was to maintain and strengthen the reputation of Berlin as a prime science and technology location, and to generate regional economic effects from the commercialisation of RNA technologies. Although this promotional measure was an exceptional and financially outstanding funding measure for the Senate of Berlin, it acted as a rather weak junior partner, and delegated most of strategic and operational management of the promotional measure to the BMBF and its project operating agencies (*Projektträger*).
- BMBF: through the promotional measure, the BMBF aimed at developing RNA technologies from infancy to an advanced stage with commercial potential and to maintain and strengthen Germany's international competitiveness in this research field. Regional impacts were of minor importance.
- Industry: taking the gene centres as a model, the original intention of BMBF and the Senate was to find one or several industrial sponsors for the network which would have been given a strong say in the thematic and strategic orientation of the network. Despite several attempts, no industrial partner could be acquired which was willing to make a substantial financial commitment. As a result, any company showing interest in RNA technologies and willing to contribute financially to individual projects was taken into the network. As a consequence, the influence of industry was mainly confined to those projects which were co-financed by the industrial partner as well as the public funding agencies.

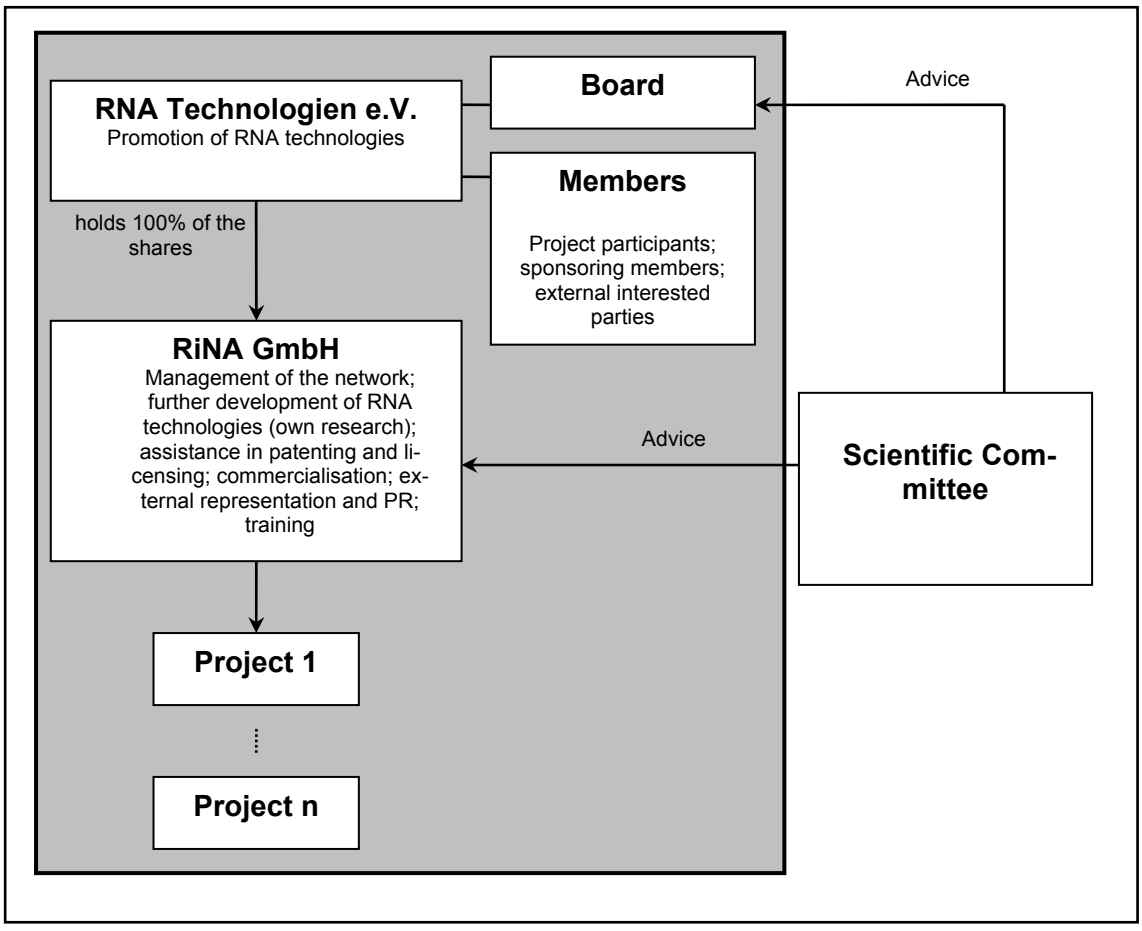
The history of this promotional measure shows that the chosen approach was not the result of a strategically and systematically designed promotional measure. Rather, several options were successively taken into consideration and were pragmatically and in a path-dependent way narrowed down to the final result, which proved to be politically and financially feasible.

Due to this complicated process of setting up the promotional measure and the implicit, diverging goals and interests of the key players BMBF, the Senate, industry (and champion), the network was established with unique structural and procedural elements which are intertwined or overlap with each other in complex ways. Figure 4 shows the established structures and bodies which are

- RiNA e.V. as the umbrella organisation of the network, with its board of directors (*Vorstand*) responsible for strategic network management,
- RiNA GmbH with two different tasks: on the one hand it serves as a sort of "spin-off company" responsible for the commercialisation of research results generated by the network, but also doing own RNA research; on the other hand, it hosts the operational network management,

- Advisory board, consisting of three renowned RNA researchers with close personal links to the network initiator and champion, responsible for general strategic advice to the network management and for the scientific peer review of research proposals,
- Network members, i.e. research groups from Berlin and companies from Germany carrying out research within the network, funded by the network budget,
- Steering committee, a committee with representatives of BMBF and the Senate of Berlin. Such steering committees are usual instruments for joint funding measures of federal and regional governments, but in general only have a coordination function, without strategic tasks.

Figure 4: Structure of the Network "RNA Technologies Berlin"



Source: Fraunhofer ISI 2007

Although the strategic management was formally the task of the Board of Directors of the RiNA e.V., this body was not active in this way. Rather, strategic decisions were influenced and taken by a number of diverse bodies "when they were needed", in many cases without predefined and clear procedures, without explicitly spelled-out terms of reference or competencies, and without appropriate documentation and communication

of the decisions taken and measures to implement them. In the situation of weak strategic management of the network and diffuse and unclear responsibilities, the funding agencies exerted a stronger influence than usual. This was done via the steering committee.

Another example was the definition of the thematic orientation of the research undertaken in the network. This was the result of a bottom-up process, in which all researchers could propose projects for funding. These proposals were reviewed for their scientific quality and originality by a scientific review board, whereas the final (financial) funding decisions were taken by the funding agencies. This review process does not live up to the international standards usually applied for a funding measure of this size and duration. Although this bottom-up process makes thematic flexibility and the uptake of new research themes in this dynamic research field possible, it was not complemented by a top-down strategic process which could have aimed at identifying possible synergies within the network which go beyond project cooperations, and develop them strategically. Network members were not actively involved in other network-shaping activities beyond the submission of proposals. This may have contributed to the weak development of a network identity.

Network management and champion relied heavily on the long-term funding guaranteed by the funding agencies and neglected the acquisition of additional funds from other funding agencies on a network level. Moreover, no serious attempts were undertaken to establish lasting structures within the hosting university which would have allowed the sustainable continuation of RNA research even after termination of the BMBF/Senate network funding.

7 Lessons learned for the design of future policy measures in RNA technologies and similar regional networks

7.1 Improvements in the design of the funding measure "Network RNA Technologies Berlin"

The evaluation concluded that a continuation of public funding of the Network RNA technologies Berlin can be recommended, provided that the following amendments are satisfactorily implemented:

- Clear division of network management activities from commercial and scientific activities within the RiNA GmbH, in order to avoid conflicts of interest,
- Implementation of a peer review procedure according to international standards,
- Establishment of effective structures and procedures for the development, implementation and auditing of a network strategy,
- Development of a sustainable funding concept and business model.

7.2 Public funding of RNA technologies on a national level

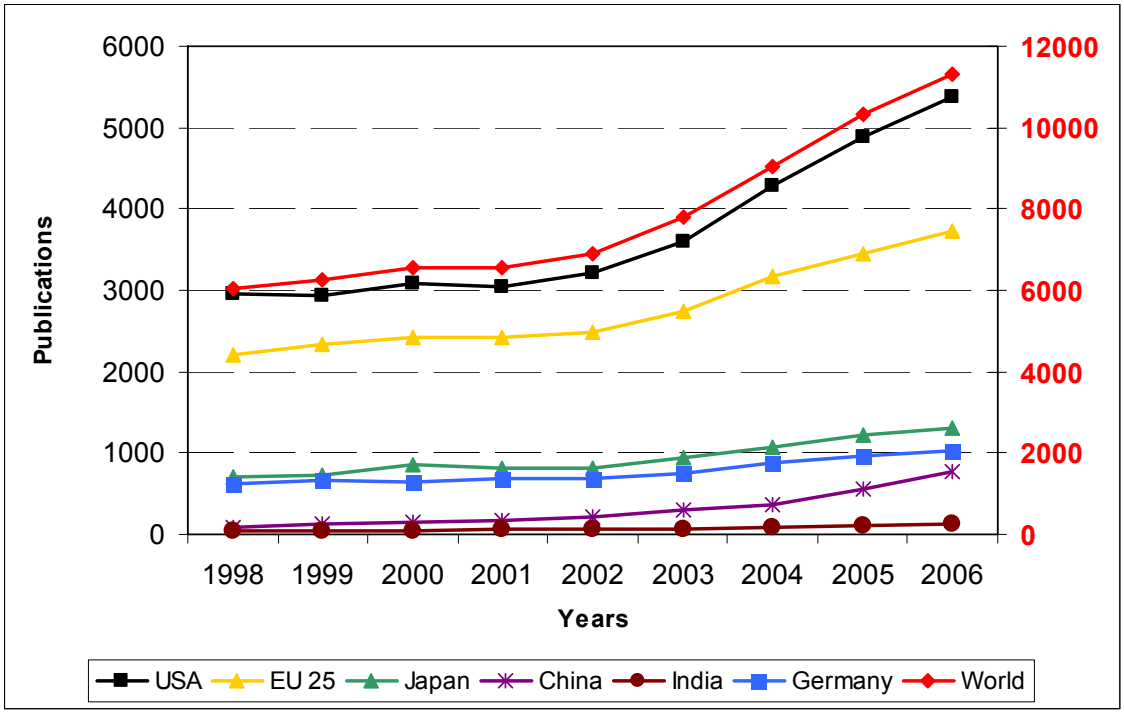
Whereas it seemed appropriate in the early 1990s in the infant stage of development of RNA research in Germany to tailor a funding measure for RNA technologies around a champion in this field and thus design a measure with a regional focus, this decision requires reassessment with maturation of the field: Meanwhile, in 2007, many research institutions, especially academic and non-academic research institutes, pharmaceutical companies and dedicated biotechnology companies were active in RNA research and RNA technologies. These actors are distributed all over Germany. A total of four leading regions have reached critical mass in RNA technologies: Berlin, North Rhine-Westphalia (Cologne, Aachen, Düsseldorf, Wuppertal, Münster), Munich and the Rhine-Neckar Triangle (Heidelberg, Mannheim, Ludwigshafen). These regions are characterised by a critical mass of research actors, high publication and patent application activities, and significant acquisition of public funding from diverse funding agencies (table 4). They contribute nearly equally to Germany's internationally competitive position in RNA research: together with the USA and Japan, Germany is among the leading countries (figure 5). Within the EU25, Germany is the leading country, having a share of 30 % of all RNA publications and 30-40 % of all RNA-technology-related patent applications (data not shown).

Table 4: Ranking of German regions according to selected performance indicators (publications, patent applications, acquired BMBF funding) in RNA technologies

Region	Rank Publica-tions	Rank Patent Applications	Rank BMBF-Funding	Average
Heidelberg/Mannheim	2	3	1	2,0
NRW (incl. Münster)	3	1	2	2,0
Berlin	1	4	4	3,0
Munich	4	2	3	3,0
Göttingen	8	5	6	6,3
Frankfurt/Giessen	5	8	8	7,0
Tübingen	10	11	7	9,3
Franken	13	7	9	9,7
Hamburg	9	13	10	10,7
Miscellaneous	6	9	17	10,7
Marburg	11	6	17	11,3
Dresden	17	14	5	12,0
Freiburg	15	12	11	12,7
Kiel/Lübeck	7	19	14	13,3
Potsdam/Gatersleben	18	10	17	15,0
Braunschweig/Hanover	12	18	17	15,7
Mainz	19	16	12	15,7
Jena	20	17	13	16,7
Würzburg	14	20	16	16,7
Halle	21	15	17	17,7
Münster (included in NRW)	16	20	17	17,7
Ulm	23	20	15	19,3
Regensburg	22	20	17	19,7

Source: Fraunhofer ISI analysis, 2007

Figure 5: Publications in RNA technologies 1998-2006; selected countries



Source: Fraunhofer ISI search 2007; data: SCI, Thomson Scientific (publications); search at host STN

In order to maintain and strengthen the leading position of Germany in the scientifically and economically rewarding field of RNA technologies, it was recommended to continue public funding of RNA technologies in Germany with a focus on application-oriented research. Industry should play a significant role, both in financing and research. High priority should be given to the promotion of junior scientists.

With respect to the design of future funding measures, four options and their respective pros and cons were elaborated which all form a plausible continuation of RNA technologies funding. They differ with respect to their structure (network or project-based research programme without structure-forming functions), their spatial scope (regional cluster or nation-wide measure) and the model of financing (only BMBF; BMBF and industry; BMBF, *Länder* and industry; public-private partnerships).

- Option I: continuation of the regional Network RNA technologies, Berlin
- Option II: several regional networks at different locations in Germany.
- Option III: one nationwide network
- Option IV: nationwide research programme with project funding (and additional measures, e.g. promotion of junior scientists), without network activities

Which of these options is chosen for further funding, is a political decision in the first place.

8 Main findings

On the basis of the research questions formulated in chapter 4, the following findings can be drawn from the empirical analysis:

What kind of policy measures can be taken in order to activate and support scientific-technologival developments under given regional framework conditions?

With the aim of establishing a national competence and technology transfer centre for RNA technologies in Berlin, the Federal Ministry of Education and Research, the Senate of Berlin and industry jointly funded a research and technology transfer network for a 10 year period from 1998-2007. The network was initiated by and constructed around a leading German scientist in RNA research (champion). The inclusion of industry reflected at the same time the mission to conduct application-oriented research as the main focus. The major aim of the promotional measure was to establish a national "Competence and Transfer Centre for RNA Technologies" in Berlin. The Netzwerk RNA-Technologien Berlin should serve as a "focal point in the establishment of RNA technologies in Germany". The initial assumption, that RNA technologies are a scientifically rewarding research field with substantial technological and economic potentials, has proven valid: within Germany, Berlin is one of several top locations with respect to the competencies and prerequisites to unfold the potential of RNA technologies. Therefore, the establishment of the Network RNA Technologies in Berlin is seen positively and is strategically smart.

Which are the major challenges encountered regarding the multi-level governance of a funding measure?

The network RNA Technologien Berlin was jointly funded by the Federal Ministry of Education and Research (BMBF), the Senate of Berlin and industry with a total budget of € 47 m for a 10 year period from 1998-2007. The coordination of the funding measure proved to be quite challenging, given the fact that the BMBF, the Senate of Berlin and industry pursued slightly different aims: the BMBF primarily implemented the funding measure on a regional basis in order to achieve national goals, thus the region of Berlin was used as a platform to strengthen Germany's international competitiveness in this particular research field. The Senate of Berlin meanwhile pursued primarily regional goals with the funding measure. To maintain and strengthen Berlin's reputation as a prime science and technology location and generate regional economic effects are the main objectives. Meanwhile, the influence of the industry remained mainly confined to projects which were co-financed by the industrial partner as well as the public funding agencies. Due to the long-lasting and complicated process of setting up the funding

measure and the implicit, diverging goals and interests of the key players BMBF, the Senate and industry (and the champion), the resulting network is characterised by unique structural elements which are intertwined or overlap with each other in complex ways.

What regional and national effects do such funding measures have, especially within the context of the creation of a regional research and innovation network?

On the basis of indicators that were used to assess the technological and scientific performance of RNA research in Germany in the course of the ten year period, the following impacts were observed: an increase of publications and patent applications worldwide, a significant increase in public funding during the last decades, both nationally and internationally, an increasing number of RNA companies (presently approx. 100 worldwide) and a strong increase in (financial) commitment of pharmaceutical companies in this field. Regarding the network effects, a relatively stable core of members which remained constant over the 10 year funding period has been constituted. These core members were complemented by members who joined or left the network and only participated for shorter periods of time. Due to the promotional measure which funded primarily cooperation projects, the cooperation intensity of scientific institutions with companies was increased significantly, in this way contributing to the goal to foster the commercial exploitation of research results. Approx. 50 % of network members established new cooperations, one quarter cooperated with new partners not known from previous activities.

What are the major conclusions regarding the further improvement of the funding measure and which implications can be deduced for other regions with similar technology starting conditions?

In the early 1990s in the infant stage of development of RNA research in Germany the funding measure for RNA technologies was tailored around a champion in this field. The design of the measure contained a regional focus, but this decision requires reassessment with maturation of the field: in 2007, many research institutions, especially academic and non-academic research institutes, pharmaceutical companies and dedicated biotechnology companies are active in RNA research and RNA technologies in other German regions (for instance Munich, Heidelberg, Cologne and other regions in North Rhine-Westphalia). Thus, with respect to the design of future funding measures or the improvement of the existing ones, four options and their respective pros and cons form a plausible continuation of RNA technologies funding in Germany. They differ with respect to their structure (network or project-based research programme without structure-forming functions), their spatial scope (regional cluster or nationwide

measure) and the model of financing (only BMBF; BMBF and industry; BMBF, *Länder* and industry; public-private partnerships).

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