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Dorothea Jansen

# Governance of research networks

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Discussion Papers

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*This paper presents an outline of the program of a larger research group that tackles the question of innovations in the governance of the German research system. The special focus is on one of the projects which deals with networks as a special kind of governance mechanism and on the interplay between reforms in the research system and the network strategies of research groups.* [1]

## 1. Governance of the German Research System

The German research system is under high political and economic pressure. Its performance and by now also its willingness to perform have come to be debated. After numerous evaluations of almost any research organization a fundamental reorientation of the German research system, of universities and research organizations, is beginning to be felt in practice. For instance, the DFG, the German Research Association responsible for funding of mainly university research, the big science centers or the so called „Blue List" research organizations with a special joint laender/federal funding procedure as well as several universities were evaluated during the last years.

Reforms aim at the implementation of internal business management procedures as well as at a general change of external governance from state regulation to more contractual forms of governance and competitive markets (New Public Management). The management of scarce resources by program budgets and strategic concentration, the quest for collaboration and network building among researchers from different institutional backgrounds, and the call upon universities and research organizations to sharpen their profiles are other issues of reform debate.

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1 This is a revised version of a paper I first presented at the ICS Colloquium at Utrecht on 27th of June 2003 during a sabbatical at the Interuniversity Consortium for Social Science Theory and Methodology at the University of Groningen. Funding of the NWO is gratefully acknowledged. For helpful comments I want to thank *Vincent Buskens, Andreas Flache, Werner Raub, Tom Snijders, Frans Stokman* and *Rafael Wittek*. I also would like to acknowledge helpful comments from *Emmanuel Lazega* and *Lise Mounier* with whom I discussed the project during a visit at the IFRESI, University of Lille on 15th of March 2004.

What is missing is a systematic and empirical analysis of the effects, cross- and counter-effects of this whole mix of reform measures. The reforms are implemented without a thorough analysis of their consequences for the research capacities of the system, without an analysis of their effects on competitiveness and innovative capacities of the German research system. The research system often is neglected. The reforms mainly aim at the teaching duties of the system of Higher Education.

In July 2003, the German Research Association (Deutsche Forschungsgemeinschaft) approved of funding for a larger research group on "International competitiveness and innovative capacities of universities and research organization" that is undertaking to explore the new forms of governance in the German science system with a special focus on its research function. The group for the first time brings together researchers from different specialties such as Higher Education, science policy, science and technology studies and science and public law. Coordination is located at the Research Institute of Public Administration at Speyer.[2]

The research program of the group targets the following objectives:

- An inventory of reforms on paper and in practice, also including developments of reforms abroad and analysis of the options for a transfer of these models. This is not as easy as it looks, since Higher Education and Science is a domain of the laender. Federal frame laws combine with state laws for the reform of universities. There are also a lot of different institutional solutions for the conflict between the states and the federal government over the funding and governance of other science organizations like the DFG, the Forschungszentren or the Blue-List-Organizations.
- Identification of different governance mechanisms and their concatenation into forms or patterns, particularly in multi-level systems. This is very important in order to dig into the problem of counterintuitive and unwanted consequences of the reforms.
- Analysis of the micro flow of causes and effects and of causal mechanism underlying the effects on research behavior and research output. This will be measured by quantitative and qualita-

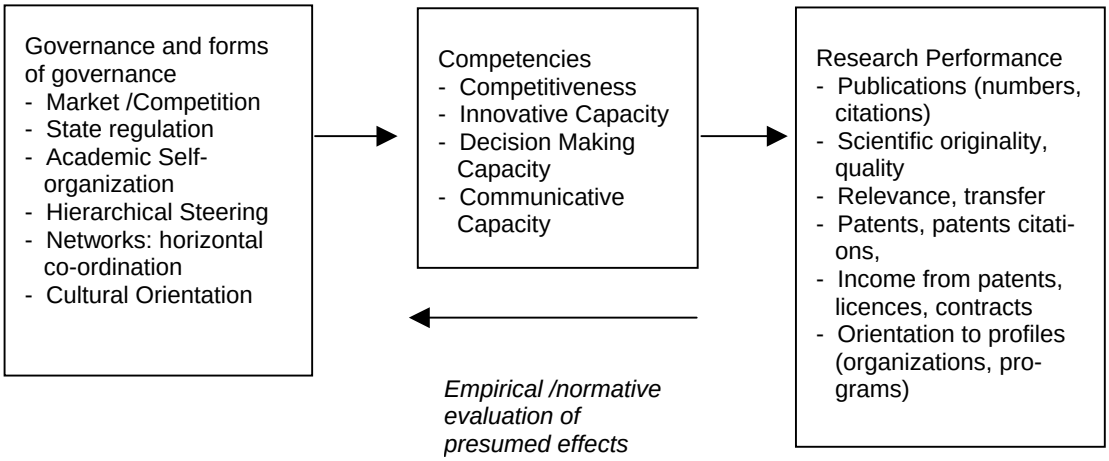
2 See the table with more information on the seven projects in the annex.

tive indicators and on several levels of aggregation/emerging effects.

- Identification of typical forms of governance, their empirical distribution and search for innovative forms.
- Analysis of the positive and normative conditions for the implementation of new forms of governance in the research system. There from some handles for the co-steering of the system and some viable strategies for the reform process should come out.

There is no interdisciplinary theory of governance, yet.[3] And neither there is an application to the governance of research. The lack of theory is part of the problem that the group is dealing with. Starting point for the empirical research is a preliminary model of governance of research systems that came out of the discussions of project designs in the two-years gestation phase of the research program (figure 1).

**Figure 1: Preliminary Theory Model – Governance of the Research System**




3 But see the diverging disciplinary approaches. Transaction cost economics: *Williamson* 1975, 1991, 1994; new public management: *Osborne/Gabler* 1992, *Budäus* 1995, *Naschold* 1998, *Blanke* et al. 2001; actor centered institutionalism: *Mayntz* 1993, *Mayntz/Scharpf* 1995, *Scharpf* 1995; governance of higher education: *Clark* 1983, 1998, *Braun* 1999; networks and culture as governance mechanisms: *Sabel* 1994, *Powell/DiMaggio* 1991, *Powell* 1990, *Scott* 1995, *Granovetter* 1985, *Powell/Smith-Doerr* 1994; *Podolny* 2001; regulatory structure as an interdisciplinary bridging concept: *Trute* 1996, 1999, *Schmidt-Aßmann* 1998, *Schuppert* 2000.

On the left hand side six governance dimensions are differentiated along their use of mechanisms either within or external to the organization. They also can be compared along the degree to which they are secured by normative or legal sanctions. The central questions then are, which combinations are logically possible, empirical existent, and finally do contribute to competitiveness and innovativeness of the research system.

Governance dimensions are characterized by a bundle of rules that define who are the actors, what are their rights and duties, what are their pay-offs from transactions and what are the sanctions to expect in case of undue action. For instance, market governance defines the partners of a market transaction as equals in a one shot transaction. Pay-offs come from differences in the utility functions of the actors in the market exchange of goods and services. Markets open options for exchange, they do not prescribe a particular behavior. Sanctions are mostly not of a legal kind although legal enforcement of contracts is part of the infrastructure of markets. Sanctioning is mostly done ex post and behind the back of the actors by market forces/competition. In large numbers bargaining buyers simply will not do business with suppliers, whose offers are not competitive in terms of price and quality. As is already indicated by the role of legal enforcement no single governance dimension is really self-sufficient in coordinating actions. This is very much a phenomenon of layers of governance that constitute complex forms or patterns of governance. On the micro-level the actors or firms in a market must be able to adapt to market signals via their internal governance. On the macro level legal enforcement or institutions to guarantee some other standards (currency, quality, safety) are necessary for the functioning of a market. Sociologists argue that neither large numbers nor one shot transaction characterizes real markets. Thus, face to face and informal sanctioning of unreliable behavior by exit and gossip supplements market forces and legal options. So, governance on one level needs complementary governance on upper and lower levels, and at the own level the dominant dimension usually is supplemented by some other “underground” mechanism, too. [4]

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4 A prelinimary list of important characteristics of governance dimensions/ mechanisms contains the following attributes:

- Type of relation between actors: equal footing or authority, exit conditions, temporal and/or social embeddedness,

Governance patterns determine competencies in the research system at several levels of aggregation– as macro as a whole science organization like, for instance the DFG or the Max-Planck-Gesellschaft and as micro as a particular research group. These competencies intervene between governance and research performance. And the larger organizations constitute the environment with specific incentives, traditions and sanctions for the smaller entities.

The research program of the group will focus on four competencies: competitiveness and efficiency, long-term innovative capacity, capacity to reach decisions and implement them, and finally the communicative and network capacities. Certainly trade-off within and between the dimensions are to be expected. For instance, the innovativeness of a decision may make it impossible to implement it or short-term efficiency might undermine long-term innovative capacity.

To grasp research performance several indicators have to be taken into account. The group engaged in an intensive discussion of the indicators that were selected for a comparative measurement and interpretation (cross-validation). Trade-off between indicators is quite likely, e.g. between quantity and quality of output or between originality and innovativeness and contribution to the organization‘s profile or research contract income. Indicators are analyzed on several nested aggregate levels, too.

Finally, the group strives for an empirical and normative evaluation of effects of reform measures and new laws and regulations. It is, for instance, an open question whether the change of organizational forms to civil law forms trigger more efficiency or whether the recently implemented university councils actually make for an increase in applied research.

Strong collaboration within the group will make it possible not only to transfer data from one project to another, but also to transfer context sensitive and tacit knowledge. We will strive to make explicit and

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- Type of coordination between many actors: ex post via impersonal mechanism (markets, polls, evolution by different survival/fertility rates) or ex ante/face to face,
- Type of coordination of actions: prescribing actions, forbidding actions, allowing for coordination by voluntary contracts/agreements,
- Type of incentives: positive or/and negative, degree of formality in transmission, private vs common goods.

understandable the disciplinary perspectives and interpretations in an intensive methodological and theoretical discussion and to get at a joint interpretation of our research data. This will make it possible to paint the contours of a theory of the governance of research. This theory, of course, cannot be general and abstract, but just a middle-ranged theory. It will need a long process of understanding and going back to „showing ideas in concrete case analysis“ – on cases that are common knowledge of the group.

## 2. Networking strategy and network capacity of research groups

One of the projects within the overall research program focusses on the question of the governance of research networks, and particularly with effects of institutional structures and reforms on network capacity and network strategy of research groups. This project and the problems around using networks as a “soft” governance mechanism are presented in greater detail here.

First, I will say some words on the role of networks in the production of scientific knowledge and their prominence in recent debates on reforming the research system in Germany. Then, the central research questions underlying this project are introduced. Third, I will deal with the role of the network project within the research group‘s program as a whole and the significance of networks within new patterns of governance. Fourth, some words on the design and the operationalization of the central concepts, networks, networking capacity and network strategy. As a conclusion, I will present some ideas for further research in modeling the evolution of research networks and their long-term benefits and liabilities.

### 2.1 Networks and a new mode of knowledge production

The information society, the knowledge society and the network society are metaphors trying to catch important characteristics and changes in modern societies. One of them is the idea that a new mode of knowledge production is emerging. This thesis was put forward by a group of scholars in the sociology of science (Gibbons et al., 1994, Etzkowitz/Leydesdorff 1997, Nowotny et al. 2001). They postulate

that not just everyday knowledge but also scientific knowledge arises today from distributed production connecting producers and users from different disciplines and subsystems.[5] Collaboration and networking between these actors become vital not only for the production but also for the legitimacy and use of knowledge. Users and their interests thus will have a larger say in the definition of research programs. Responsiveness and accountability are new demands for the science system.

Networks are important for the production of knowledge because knowledge often is not codified but tacit. It resides in the heads and hands of people, within organizational routines and in inter-organizational networks. Knowledge is embodied and embedded.

These ideas also became topics in the political debates on reforming the German research system. Shortcomings in quality and quantity of research output, in competitiveness and innovativeness of the system are attributed to a deficit in collaboration and networking between disciplines, different types of research organizations, basic and applied research. More collaboration and heterogeneous collaboration and networking is asked for and sanctioned positively by more and more funding agencies and programs.

## 2.2 Research questions

Given that networks are getting more important for the quality, effectiveness and efficiency of research, the question must be dealt with how they actually do work. And how they might be stimulated by changes in the internal and external governance of research organizations, like internal rules for the distribution of funds or external boards and their advice and influence.

The quest for building networks comes along with a second reform issue: the idea of strategic concentration of funds on selected research programs. At the meso-level, organizations are advised to concentrate on core competencies and sharpen their profiles. Albeit, it is not at all clear how an increase in networking and concentration of resources will influence innovativeness and competitiveness of the research sys-

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5 This comes close to a strong task interdependence or pooled interdependence in terms of organizational analysis (*Thompson* 1967) or co-specialized assets/co-production (*Alchian/Demsetz* 1972) in terms of economics.

tem. There are a lot of interaction effects with other measures of New Public Management. This might very well result in counterintuitive strange effects like crowding out of intrinsic motivation or inflation of performance standards as a reaction to known evaluation criteria.

One of these problems is the choice between generalist and specialist strategies in research groups. What will research groups do when they are confronted with a highly volatile research area and concentrated resources i.e. focussed funding programs and internal profile building?

From the point of view of organizational ecology, focussed research programs constitute a coarse grained environmental niche (Hannan/Freeman 1977). Science and engineering is characterized by a so-called concave fitness structure, i.e. large differences between the demands of different research lines and methods. In terms of Transaction Cost Economics (Williamson 1975, 1994) this means high asset specificity and eventually high sunk costs. Concave fitness structures ideally should lead to high profits from specialization. But combined with coarse-grained environments and high volatility, population ecology predicts a more generalist strategy as a hedge against long phases of not fitted demand structure. De-differentiation and a loss of profits from specialization could be the consequence. Generalist strategies would also lower the need for external collaboration and networking.

Another question is how the strategy of research groups and its efficiency and effectiveness depends on type of organization and its size. It might very well be that under these conditions only large research organizations are able to profit from specialization via internal differentiation and the management of portfolios. This is the prediction of internal procurement and divisonalization in the perspective of Transaction Cost Economics. But large organizations would probably try to do all the work in-house in order to get the largest piece from of a program budget.

Networks ideally allow for the bundling of resources. Thus, they might be able to solve the critical mass problem of the smaller research groups. They might be able to profit from their heterogeneity and innovativeness. They might preserve variety. On the other hand networks combined with the concentration of resources on large programs might lead to lock-in effects. They might undermine the emergence of new research lines, which happen to fall outside of focussed programs and profiles. Whether this will happen largely depends on

the mixing of networks with other governance mechanisms. For instance, what are the choices and resources left to an individual or a group, and what is decided by strong deans, research directors and presidents or newly established university boards?

Also, it is perfectly unclear how collaboration in networks can be combined with the call for more competition. Networks as a governance mechanism imply reduced competition at least for a while. This is easier between strongly specialized groups. An intensification of competition between the pillars of the German research system albeit might lead to de-differentiation and more uncertainty in expectations on the behavior of other groups and organizations. This could – in a worst case scenario – end up in less external research collaboration and/or lower specialization and productivity.[6]

To sum up, the project sets out to analyze the mechanisms of specialization and coordination, of voice/loyalty and exit in research networks in detail. The aim is to identify those combinations and their institutional prerequisites, which allow for innovative network structures and research. What makes for a sustained balance of collaboration and competition? Which strategies and structures allow for variety and the spread of risk to prevent the danger of lock-in on the one hand and the combination of co-specialized resources to arrive at a critical mass on the other hand?

## 2.3 Governance forms, networks and network capacities, research performance

Core concepts of this project are the competencies derived from networks and their structural and strategic prerequisites on the level of

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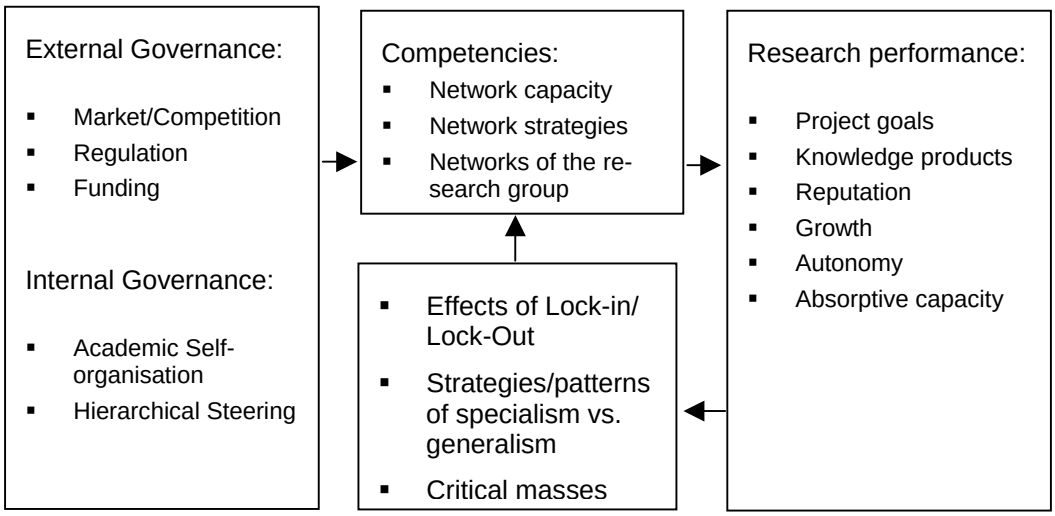
6 Competition between the emerging structure of large generalists leaves small spaces of demand open for flexible small newcomers on the fringes of the niches. This is described by the model of resource partitioning (*Carroll* 1985, *Carroll/Hannan* 2000). Whether or not these potentially innovative small research groups can succeed in a market with highly concentrated and politically defined demand is an open question. Another one is whether the smaller units within the large differentiated organizations can build up their own network and innovative capacities. This will again depend on the internal governance of the organization and on the level(s) on which competition is fostered and autonomy and options for an independent choice are provided.

the research group. These variables are intervening between internal/external governance patterns in the organization and research performance of the groups. I conceive of research groups as competent and strategic corporate actors. They need to adapt their networks and strategies to existing conditions within their organization and their research area. But they are also able to learn and to change their strategies, structures and competencies. This is indicated by the backward loop in figure 2, which is center stage of the project design. „Objective“ data concerning the internal and external governance of the organizational homes of the research groups are largely contributed by the collaborating projects in the research program.

**Figure 2: Model for the Analysis of the Governance of Research Networks**




How can the effects of internal and external governance of the organizations on the networks of research groups and their performance be made visible? The project will approach this problem by analyzing three types of ego-networks of the research group: the network of research related communication, the network of research collaboration within probably overlapping projects, and the buy-in network in the home organization aiming at influential people and decision bodies. An analysis of their communication networks and buy-in networks and the related strategies will be able to discover effects of changes in internal and external governance patterns on the practicalities of research projects and collaboration. Particularly, constraining effects of resource concentration and lock-in effects stemming from an overlap

of search for research money and search for research ideas in communication networks will come to the fore.[7]

A coupling between ideas and funds can also take place within one's organization. Buy-in networks will show whether internal hierarchies become more important, whether they allow for internal concentration and the build-up of critical mass or whether they constitute a problem for the group. We can assume here that an increase of organizational flexibility in the distribution of resources and staff might open up opportunities for new research lines and building of new networks. Albeit, increased formalization and regulation might as well overburden research groups. Also, the orientation towards organizational profiles once established might end up in an ossification of existing networks at the expense of new opportunities.

Different rules of matching internal and external funds might not only enhance responsiveness of research but could very well put research networks under indirect external pressure, too. Depending on the structure of external funding agencies (heterogeneity, market power, absorptive capacity for new research lines) and on the amount of internal autonomy still allowed for, this might either lead to abstention from innovative but risky projects or improve selection strategies.[8]

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7 Indicators could be whether outputs from the projects include and integrate different types of knowledge. For instance, is it possible to keep knowledge of materials and special context conditions secret while at the same time publishing in international journals? What makes it possible for a group to profit from knowledge in materials or instrumentation from collaboration with industry in a new research line? How can knowledge from one project be transferred to another one, without breaking rules of confidentiality?

8 Concerning the lock-in problem, an indicator might be the balance of two important audiences for research output, the scientific community and the public/corporate users in the communication networks. Another one is the structure of output of a group. Next, the network of project collaboration will be informative. Are there new ties and research questions? Is there enough autonomy and resources to follow up new research lines?

## 2.4 Operationalizing networks, network capacity and network strategy

From the perspective of institutionalism, a network is a type of governance structure between markets and organizations.[9] In SNA networks are used less metaphorical but with a clear-cut technical meaning. Nodes and edges define a network. Nodes usually symbolize actors, edges relations. Their most important structural characteristics are the amount of weak ties and strong ties and the degree of either closure or openness (density, reciprocity, transitivity, structural holes) of the network. Networks of high density and closure with a high proportion of strong ties come close to the governance concept of networks. On the other hand, networks of low density with many weak ties and structural holes come close to markets. The methodological concept of networks allows describing different governance structures using the same instrument in a meaningful and reproducible way.

Three types of ego-centered networks will be analyzed on the level of the research group: (1) research related communication (research questions, new lines, funding), (2) collaboration in research projects, (3) buy-in networks to ties in the home organization which are vital for the institutional backing of projects/resources.

Dense networks with many strong ties create trust and allow for non-strategic collaboration in the shadow of joint informal institutions/rules. This lowers transaction costs in learning processes and is particularly important for the co-production, transfer and use of implicit and private, may be patented knowledge. These networks on the other hand build-up barriers for entry and exit. Thus, in the long run, they might lead to efficiency losses. It is perfectly unclear, what the mechanisms for a dynamic balance of weak and strong ties, of voice within a closed network, exit out of less productive ones and entry into more promising ones could look like. To achieve this, a group needs network capacity and a viable network strategy. Both are dependent

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9 In a TCE perspective, networks are the answer to the dilemma of combining flexible action in highly uncertain situations with trustful collaboration in an almost organization-like setting, allowing for co-specialized competencies/resources and high asset specificity. Institutionalist approaches in economic sociology use the term in roughly the same meaning. This governance concept of network must be distinguished from the methodological conception of network, which is typical for Social Network Analysis (*Jansen* 2002).

on other governance mechanisms within the organization and external to it, and both will influence the research performance.

A reproducible measurement of the ego-networks of the group, its resources, the action strategy and constraints of the network actors will make it possible to identify influencing factors and innovation-prone networks and network mechanisms.[10]

The unit of analysis is the research group on the micro level. This is supposed to be the level of doing research work. Research groups are bounded units which are nested within formal organizations, departments or faculties, universities or non-university research organizations. This could be a department within a non-university research institute or an institute within a faculty or the research group of a chair

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10 Tasks for project networks are most heterogeneous:

1. Cognitive-social focussing of a joint goal and absorption of uncertainties. (Where shall we go, if we do not know what we are looking for?)

2. Problem of motivation: exchange structures and exchange rules governing internal relations and guaranteeing trust and high information depth.

3. Rules for the conditions of entry and exit, when projects end/fail, when collaboration ends/fails, when new collaborations/projects are established.

Tasks for Buy-In-Networks: guarantee resources and good will within the organization. Make things happen.

Tasks for communication networks: search for new ideas and funding, search for exit options, new ties, new projects.

Indicators for social capital of networks, of lock-in effects, of lock-out mechanisms:

Stability of ties, density, multiplexity, cohesion/reciprocity and cliquishness provide social capital in the sense of trustful research collaboration. Large size networks, many weak ties, many non-group but personal ties, structural holes and low overlap between projects, changing ties/new ties provide social capital in the sense of information and arbitrage profits. Trust Role Structures and their stability (but not stability of any particular tie) might yield a balance between under- and over-embeddedness.

Lock-in effects can be identified by comparing communication and collaboration networks (more overlap = more lock-in). Another way is to look at the amount of new or young ties in collaboration networks, at the degree of overlap between ties from different projects, at the longevity of ties, institutional back up of ties, high and growing similarity of network participants. Large heterogeneity, more informal, young, personal ties and a large and heterogeneous communication network open opportunities for new research lines.

holder. Their research deals with a particular area within a (sub-)discipline. Research work is organized in projects, usually more than one. These tend to be co-ordinated by an overarching research goal. Members of the group may work in more than one project. Groups can be identified according to their main research area.

The sampling procedure builds on a bibliometric analysis of the research areas selected for the research program of the whole group (mediavistics/history, micro/economics, astrophysics/astronomy, nanotechnologie, red biotechnology). The procedure will aim at securing scope in the following dimensions:

- prima facie performance of the groups,
- research areas (1 mode-2 area: nanotechnology, 2 mode-1 areas: astrophysics and microeconomics)
- organizational context (university, non-university)
- Size of the groups.

75 research groups were selected for an interview study. Data on ego-networks, network strategies and their importance for the research process can only be collected in face-to-face interviews. Interviews were conducted at the level of the group leader. In order to get at learning processes and changes in the network strategies and structures a longitudinal approach is needed. In the third year a second interview based on the results of the first ones will be conducted in a telephone survey. Data on their networks together with an overview on typical network patterns in the research area will be made available to the subjects before the interview.

Context data on the research areas, the organizational homes of the groups and partly also their performance data will be contributed from other projects or from bibliometric databases. An evaluation of the performance of individual projects and learning processes can again only be collected in face-to-face interviews. Performance indicators from bibliometric analysis will of course be cross-validated by a host of other indicators from all projects with an empirical design and will be discussed in the group.

## 3. Where do we go from here: Modeling network evolution

To really understand the dynamic "behavior of networks" models are needed which describe the evolution of strategies and learning at the micro-level of research groups driving the level of macro-outcomes like network structures, research outputs and profits for the research group and the network/area as a whole.

This implies a longitudinal research design. Follow-up interviews will take place in spring 2006 and in the second phase of the project. This will give us a picture of the Ego-Networks of 75 research groups over 4-5 years. These ego network data will be complemented by bibliometric data on co-publication networks covering the research areas selected for further study.

Figure 3 assembles the first ideas on what could be important building blocks for a dynamic model of networks. On the left-hand side I begin with the project networks of the group at time $t_1$. Projects are nested within the research collaboration network of the group. Partners and their relations are described to grasp the heterogeneity/similarity, closure and role structure in the task networks. Each project's salience (scientific importance, organizational importance, and allocation of resources) in the research portfolio of the group, the task structure and the degree of interdependence and competition between the research partners is measured. Finally, ego's size, status and capacity are important.

I expect important differences between research areas depending on their task structures. Astrophysics and economics might be less task-interdependent in collaboration than biotechnology and nanotechnology. Collaboration in the latter areas, thus, needs more coordination and trust. Also, potential damages from partners are higher.

Next, I expect differences from organizational governance and size. The general tradeoff is that the larger and more resourceful a group or organization, the better the options to engage in network building. But the trend to in-house solutions also becomes larger.[11] In-house col-

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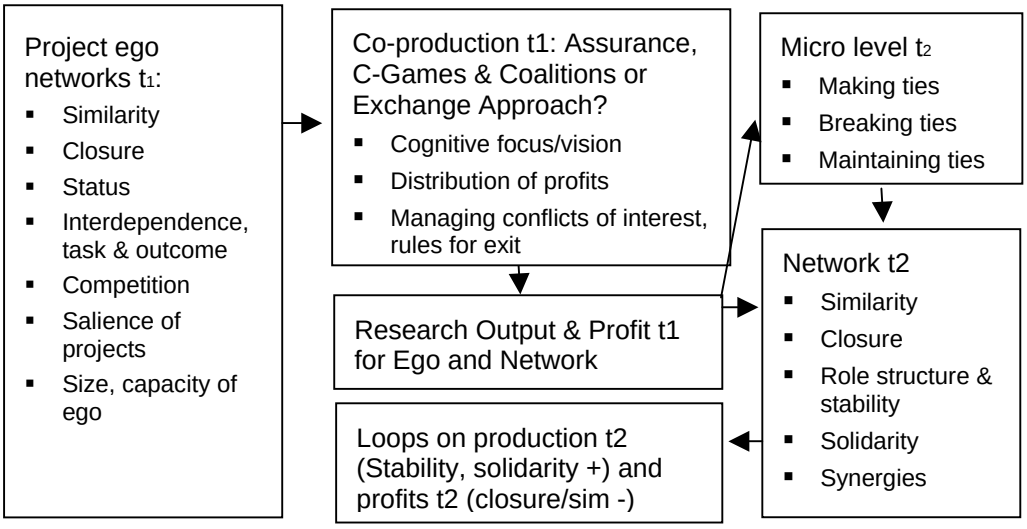
11 The larger the group, the higher its network capacity and the easier it will be to assemble a critical mass on a research line. Network strategy very much depends on internal organizational structure and governance. The larger the organization and the stronger the management, the more in-house collaboration will arise.

laboration solves a lot of trust problems but may also lead to more routine projects. In general, the more different the partners and their home organizations, the more problems need to be dealt with. [12] Potential returns increase with difference until a threshold of too much heterogeneity is crossed.

**Figure 3: Model for the analysis of network evolution**




External governance, particularly funding programs and evaluation procedures also are expected to have an effect on the type of project embarked and its management. The more concentrated the processes for funding and evaluation and the more encompassing its jurisdiction the more difficult it might be to embark on new research lines and the larger the need for timely and foreseeable outputs.

The partners, their task and their network determine the co-production game in the research projects. Each project has to deal with several problems at that stage. It needs to provide the collaborators with an interesting cognitive focus and a vision, to motivate for hard work and to inspire the search for groundbreaking new paths. It needs to make at least informal agreements on how to distribute several types of profits from the research and it needs to manage conflicts

12 There is a countervailing effect, too. The more similar groups are, the more competition there is between them. This makes different types of coordination, much more formal, necessary. From a system‘s point of view, collaboration between competitors might lead to monopolies and reduce variety in the research system.

of interests on research goals, research resources, profits and entry/exit conditions.

How could such a co-production process be modeled? One way might be to think of it as an assurance game. In research, there is little formal enforcement of project agreements with partners from different (public funded) institutions. The game may thus be categorized as without binding agreements. Assurance does not pose a collective action dilemma as long as reward (R) of multilateral collaboration pays more than defection (T), and as long as there is a stable expectation that partners also will choose to collaborate and do not opt out. But because of high uncertainty in research, shirking is not easily detected. When trust deteriorates risk avers actors might prefer to play defection. Another problem arises when the size of the rewards actually diminishes. This will happen when too much closure leads to less synergies. Assurance then becomes a weak PD (T=R) or even a strong PD (T>R) with a payoff dominant strategy for defection.[13]

Another idea might be to see co-production as a cooperative game and to try to model the fluctuation of coalitions and the returns to the partners. This seems to me to be more interesting than a network exchange approach since it will also allow deducing some hypotheses on the choice of partners at t2. These options have not been explored, yet.

Research and management in each project will determine the amount and quality of output of several types (publications, reputa-

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13 See *Flache/Macy* 2002 und *Macy/Flache* 2002 for a model of repeated social dilemma games (PD, Chicken and Assurance/Stag Hunt) using adaptive agents and learning theory. Important parameters of their model are the learning rate (higher learning rates facilitate the exploration of concurring equilibria), the aspiration level (high, low, adapting to outcomes/habituation) and fixation. Fixation is the effect of a power law of learning: learning decreases with success and increases with failures. It makes the actual learning rate dependent on the whole outcome/learning history of the agent and the actual outcome, measured relative to aspiration level. Aspiration level has some tricky effects: Low aspiration levels can drive actors into the deficient equilibrium and this the more, the stronger fixation is. Higher levels can lead actors to the equilibrium of mutual cooperation, but there is a threshold where dissatisfaction with the reward begins to drive actors towards defection. Greediness can be dampened by a high level of fixation too. So high fixation allows for collaborative equilibria with higher levels of aspiration.

tion, artifacts, patents, and further funding/contract income) and its distribution to the focussed group and its partner groups. On this base, the ego group will make its decision on making, breaking and maintaining ties in ongoing and new projects. An observation interval of five years should span at least two typical projects.

Micro-network-actions result in the network structure at $t_2$, in rules of exchange and solidarity and in potential synergies coming from the assembling of new partners, resources and ideas. The balance between loyalty/voice and exit, between lock-in and lock-out dependents on two opposing mechanisms. One is a homophily (selection & contagion) driving the network towards closure, and an increase in similarity. This supports stability and solidarity in the research network. It makes transfer of tacit knowledge and managing of conflicts easier. But there is also the danger of lock-in. Potential synergies will shrink and profits will fall when people get trapped in their own network.[14]

The second mechanism is driven by a production and innovation logic. Synergies and innovation are moving targets that actors need to follow. Decreasing returns will stimulate the search for new opportunities. Search strategies can be local and incremental, or more global and far reaching. This will be dependent on the competitive pressure and on the structure of the communication networks. Predictions on what the effect of size and status will be are not so clear. Following the argument of structural inertia one could assume a preference of

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14 *Flache* (1996, 2001) describes a similar problem of strong ties in work organizations and questions the positive effect of strong ties on the production of common goods and task effectiveness of a group. In a model of team production actors have to face two decisions, whether to invest in collective work or not and whether to invest in the relationship to their colleagues or not. While the production game is characterized by task uncertainty, in the approval game actors have full information. *Flache* shows that there is a threshold for the valuation of peer approval relative to value of task outcomes that makes relational cooperation (in dyads) easier than full cooperation. Higher values of peer dependence go indeed together with more effective task cooperation in terms of the shadow of the future that is necessary to trigger cooperation in the iterated game. But task uncertainty diminishes the region of full cooperation and enlarges the region of only relational cooperation. Task uncertainty erodes the effectiveness of informal peer control because of spill over of sanctioning of (unintended) failures to cooperate into social relations. Rates of full cooperation shrink further when large investments in the task relative to outcomes are necessary or when costs of collaboration increase more than linear.

larger groups and perhaps also of those with high status (they can loose much more) for less risky incremental strategies. On the other hand, the larger and highly reputed groups have the better options for a successful wide-ranging search strategy. Search will lead to an adaptation of research lines and to new network ties. Such a move will be costly for the first time. New research lines have to be built up without rendering returns for a while. New ties need to be integrated, trust has to be built up. This will be easier for groups if they command some slack resources themselves or if they are embedded in an organization, which gives them credit for a while.

One way of having both, synergies and innovation from variety/newness and solidarity from similarity and closure may be a stable third party/trust enhancing role structure with partly changing actors (Wittek 1999, Buskens/Raub 2002, Buskens/Snijders 2003). So it will be necessary to disentangle the effects of stability at the individual choice level and of stability of the role structure on the macro-level. The willingness to trust in yet unknown others who are embedded in a third party structure might be dependent on the trust mechanism the actor applies.

There are two mechanisms behind trust: there is, first, a backward looking learning effect. Ego learns from own experience and from experience of related others about the trustworthiness of partners. Second, there is the control & sanctioning effect which ego expects to work on potential partners via their embeddedness in the network. This is a forward-looking “strategic” attitude. Research groups who only learn might develop just personal trust and end up in closed and unproductive networks. Those with strategic attitudes towards control and sanctioning of potential new partners will develop so-called systems trust and be able to maintain their absorptive capacity for new research lines and new partners. These hypotheses on the driving forces of network evolution and on network strategy and its effect on performance will be put to empirical data in the second round of funding in the network project.

# 4. Annex

Research Group – Projects

| No. | Title of project | Contact | Affiliation | Discipline |
|---|---|---|---|---|
| P1 | Governance of the cooperation of heterogeneous partners in the research and innovation system | Prof. Dr. rer. pol. Stefan Kuhlmann<br>PD Dr. phil. Ulrich Schmoch | Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe | Social Science |
| P2 | Networking strategy and network capacity of research groups | Prof. Dr. Dorothea Jansen | German University of Administrative Sciences Speyer/Research Institute of Public Administration | Social Science |
| P3 | Comparing management and self-governance models of universities | Prof. Dr. Uwe Schimank<br>Prof. Dr. Jürgen Enders<br>Prof. Dr. Barbara Kehm | University of Hagen<br>University of Kassel und University of Twente<br>University of Kassel, Centre for Research on Higher Education and Work | Social Science |
| P4 | Innovation promoting governance structures of the German university system | Prof. Dr. Hans-Heinrich Trute | University of Hamburg | Law |
| P5 | Innovation promoting governance structures of research organizations | Prof. Dr. Thomas Groß | University of Gießen | Law |
| P6 | Organizational determinants for successfully promoting new generations of researchers with graduate programs: An institutional-economic analysis | Prof. Dr. Dieter Sadowski<br>Prof. Dr. Uschi Backes-Gellner | University of Trier<br>University of Zurich | Economics |

| No. | Title of project | Contact | Affiliation | Discipline |
|---|---|---|---|---|
| Central projects: Co-ordination and data service: | | | | |
| Z1 | Co-ordination: International competitiveness and Innovative capacity of universities and research organizations – new forms of governance | Prof. Dr. Dorothea Jansen | German University of Administrative Sciences Speyer/Research Institute of Public Administration | Social Science |
| Z2 | Data-service: Performance indicators for research institutions, in particular Research groups | PD Dr. phil. Ulrich Schmoch | Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe | Social Science |

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