12 R&D Co-Operation Between Public Research Institutions: Magnitude, Motives and Spatial Dimension

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12.1 Introduction

Universities and other kinds of publicly funded research institutions constitute important knowledge sources for innovation activities in private firms[1]. A vast body of theoretical literature has analysed the relationship between publicly funded research institutions and the private sector (see for example Bonaccorsi and Piccaluga 1994; Etzkowitz 1998; Gee 1993; Lee 1996; Onida and Malerba 1989). Correspondingly, numerous empirical studies have demonstrated that public research establishments do not exist in 'ivory tower' isolation, but are to a considerable degree involved in private sector innovation activities (see Audretsch and Stephan 1996; Faulkner and Senker 1994; Fritsch and Schwirten 1999; Mansfield 1995; Mansfield and Lee 1996; Meyer-Krahmer and Schmoch 1998; Van Dierdonck *et al.* 1990).

However, not all the knowledge transferred from a particular research institution to a firm is generated by the research institution itself. Clearly, there is not only a division of innovative labour between public research institutions and private firms, but also between different public research establishments. Researchers working in publicly funded institutions like universities usually share the knowledge they have generated with other researchers via publications or presentations and discussions at conferences. In many cases, public research establishments co-operate closely and create knowledge jointly. However, until now there has been little investigation of co-operation within the academic sector

[1] The term 'publicly funded research institutions' encompasses all research establishment that are financed to a considerable degree by the state. In Germany this includes all universities and *Fachhochschulen* (universities with a particular focus on applied studies in engineering, business and other subjects areas) as well as non-university research institutes like those of the Max-Planck or the Fraunhofer Society which are not part of the higher education system.

(see Georghiou 1998; Geuna 1998; Katz and Martin 1997). This contribution aims to reduce the gap.

While most of the previous research in this field has concentrated on co-authored scientific papers that may represent the result of joint research, here we investigate research co-operation directly. Our data has been gathered through postal questionnaires in which we asked publicly funded research establishments about their co-operative relationships. In the next section, we give a brief description of the database. The empirical evidence presented in Section 12.3 concentrates on three issues: a) the frequency of co-operation between public research establishments and reasons for non-collaboration, b) the number of collaborators and their spatial distribution, and c) the motives for research co-operation with other public research institutions. Finally, in Section 12.4 some conclusions are to drawn concerning the division of labour within the sector of publicly funded research.

12.2 Database

Our analysis is based on data gathered by postal questionnaires sent to publicly funded research establishments in three German regions.[1] The main aim of this survey was to investigate the role of public research institutions in regional innovation systems. It focused particularly on the importance of spatial proximity for a division of innovative labour within innovation systems and on differences with regard to the impact of public research institutions between the regions examined. These three regions all have a long-standing manufacturing tradition, but vary in several respects:[2]

- Baden, the western part of the State of Baden-Wuerttemberg, is a rather prosperous region characterised by far above-average performance with regard to innovation. The region has a reputation for possessing a network of transfer institutions which function well and facilitate knowledge flows between academic institutions and private sector firms, as well as co-operative networks

[1] The study was designed as a joint project involving four teams, all founded by the Deutsche Forschungsgemeinschaft. The research institutions and their respective project leaders are: Department of Economic Geography at the University of Hannover (Prof. Dr. Ludwig Schätzl), Department of Economic and Social Geography at the University of Cologne (Prof. Dr. Rolf Sternberg), Fraunhofer Institute of System Analysis and Innovation Research in Karlsruhe (Dr. Knut Koschatzky, Prof. Dr. Frieder Meyer-Krahmer) and the Faculty of Economics and Business Administration at the Technical University Bergakademie Freiberg, Research Unit Innovation Economics (Prof. Dr. Michael Fritsch). In addition to the survey of public research institutions, separate questionnaires have been sent out to manufacturing enterprises and suppliers of business-oriented services in the regions as a base for investigating the role of these types of actors in the division of innovative labour.

[2] For a detailed analysis of the innovation performance in these three regions, see Fritsch, *et al.* 1999.

among private firms (Cooke 1996; Heidenreich and Krauss 1998; Semlinger 1993). Baden is recognised as having a distinguished entrepreneurial culture. The share of small establishments is considerably above the national average.

- The region Hannover-Brunswick-Goettingen comprises most of the State of Lower Saxony which, like Baden, is located in West Germany. The region has a high share of employment in 'old' large scale industries (e.g. automobiles, steel), so the proportion of employment in new, innovative industries is comparatively low. Despite various policy attempts to improve innovation performance in this region, the innovation system is said to have considerable deficiencies (Schasse 1995).
- Saxony is one of the new German States that, until 1990, formed the socialist German Democratic Republic (GDR), which was characterised by a centrally planned economic system. The region has a long tradition in manufacturing, particularly in the mechanical engineering industry. Under the socialist regime, the region was dominated by very large and relatively inflexible economic entities that were then split up into smaller units during the privatisation process that took place after German unification in 1990.

The questionnaire was sent out to universities, *Fachhochschulen* and to publicly funded non-university research institutions. There are important differences between these three types of institutions. At the universities, research is conducted by professors as well as by teaching assistants (usually with a contract up to five years) and Ph.D. students. Quite frequently, grants from other public sector institutions or contracts with private firms provide additional research capacity.

Professors at the *Fachhochschulen* have considerably higher teaching loads than university professors and therefore have much less time for conducting research. Furthermore, there are almost no teaching assistants employed and no Ph.D. students, since *Fachhochschulen* are not entitled to grant a doctoral degree. The primary mission of the *Fachhochschulen* is education of students, mainly in the field of engineering and business administration. Ambitious research agendas are rather the exception at these institutions.

The non-university research institutions (excluding the *Fachhochschulen)* comprise several types, such as establishments belonging to the Max-Planck and the Fraunhofer-Society. Some of these institutions are financed primarily by appropriations from the state, while others rely more on research contracts with private firms or compete for public research funds. Even though a certain number of Ph.D. students conduct their research at such institutions, in general non-university research institutions are little involved in educational activities.

Due to resource constraints, our survey included only those scientific disciplines which could be expected *a priori* to be of high potential relevance for innovation activities in private firms.[1] At the universities and the *Fachhochschulen*, each

[1] These disciplines were: architecture, construction engineering, biology, chemistry, computer sciences, energy/environment/traffic, electronics, geology, mechanical engineering, material sciences, mathematics, medicine, physics, process engineering and economics.

professorship in the selected disciplines received one questionnaire. Non-university research institutions where asked to fill in one questionnaire for the whole establishment.[1] The information gathered focussed on the extent and structure of the research activities and in particular R&D co-operation with private firms as well as with other public research establishments (the questionnaire is reproduced in Fritsch *et al.* 1997).

Our data set comprises 1,020 responses classified as 'usable'. Of these questionnaires, 709 (69.5 percent of all responses) were from professorships at universities, 208 (20.4 percent) from professors at the *Fachhochschulen* and 103 (10.1 percent) from non-university public research institutions.[2] The overall response rate amounted to about 41 percent.

12.3 Empirical Evidence

Frequency of Co-Operation

In 80.4 percent of all cases in our sample, the respondents stated that they had collaborated with other public research establishments in the period 1993-95.[3] This rate was highest (96.1 percent) for the non-university research institutions followed by the universities, for which the proportion amounted to 85.9 percent. However, only slightly more than half of the professors at *Fachhochschulen* (53.8 percent) reported inter-research collaboration in the respective period. This low percentage can be mainly explained by the high teaching load and scarcity of research resources at this type of research institution. The largest difference between scientific disciplines with regard to co-operation with other research institutions occurred at the universities, where inter-public research collaboration was reported most frequently in biology/chemistry/medicine (94 percent of all responses). The lowest share of co-operating establishments was found in the field of economics (only 67 percent of all cases).

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[1] These institutions vary considerably in size. To send more than one questionnaire to each institution would have required the identification of the appropriate subentities. Unfortunately, this was not possible due to the limited resources available for the research project. We account for differences between the various types of research institutions by reporting all the results separately for universities, *Fachhochschulen*, and non-university public research institutions.

[2] The 709 responses from universities consist of 172 from Hannover, 159 from Baden, and 378 from Saxony. The majority of responses from *Fachhochschulen* (164 cases) came from Saxony, only 44 were from the Hannover region. With respect to the non-university research institutions, Hannover accounts for 30 responses, Baden for 27, and Saxony for 46.

[3] In our questionnaire, 'collaboration' comprised a variety of activities: general information exchange, generation of new ideas, joint conduct of research projects, personnel transfer, and common usage of laboratory equipment.

Table 12.1 Reasons for non-collaboration with other research institutions

Reason for non-collaboration	Percentage of non-collaborating research institutions
No necessity	44.0
Harmonisation too difficult	23.2
Other research establishments are more competitors than partners	20.2
Unusual in our field of research	14.9
Others	31.0

The non co-operating research institutes were asked why they had not collaborated with other publicly funded research establishments (see Table 12.1). In 44.0 percent of these cases, respondents stated that they simply felt no necessity to do so. This answer was given least frequently by the professors at the *Fachhochschulen,* who seem to feel the greatest pressure for co-operation, while none of the non co-operating extra-university institutes considered this a reason for non co-operation. Of all non co-operating establishments in our sample, only 23.2 percent refrained from collaboration because of difficulties with regard to harmonisation or co-ordination. None of the extra-university institutes mentioned this as a reason for non co-operation.

20.2 percent of the respondents that had no co-operative relationship with other public research institutes replied that one reason for not collaborating has been that other research establishments are perceived as being competitors rather than partners. However, there are interesting differences between the three types of research institutions. At the *Fachhochschulen*, only 15.4 percent of the professors gave this reason for not co-operating. In contrast, 50.0 percent of the extra-university research institutes regarded other public research establishments more as competitors than potential partners. This can be explained in part by the need of many non-university research institutes to earn a relatively high proportion of their budgets through research contracts with private firms or by competing with other research establishments for public funds.

Only 14.9 percent of all non co-operating establishments cited as a reason for not collaborating the fact that collaboration is unusual in the respective research field. Remarkably, none of the non-university institutes mentioned this motive. The share or university professors who found collaboration with other public research establishments unusual, was relatively high in the social sciences, in engineering sciences and in architecture, whilst this motive was largely unimportant in the fields of mathematics, physics, biology and in medicine. The most frequently named 'other motive' for non-collaboration were 'lack of time' or 'lack of resources'. In particular, professors at *Fachhochschulen* very often considered this a bottleneck for co-operation with other research institutes.

Number and Geographic Distribution of Co-Operation Partners

The number of co-operating partners does vary significantly between the different types of institutions that maintain collaborative relationships with other publicly funded research establishments. On average (median value) university professors collaborated with six partners (see Table 12.2). In Saxony the number of co-operation partners was slightly lower than in the other regions. Professors at *Fachhochschulen* had far fewer partners (only three), with no differences between Hannover and Saxony.[1] Not only did professors at *Fachhochschulen* co-operate less frequently with other public research institutions (as shown in the previous section), but when they co-operated, they also had a smaller number of partners. Thus, the integration of *Fachhochschul* professors within the scientific community appears to be weak in a double sense.

The rather large number of co-operation partners of non-university research institutions (14 partners on average) was to be expected due to the relatively large amount of research conducted there. Researchers in these institutions normally have no significant teaching load and are therefore able to devote a large proportion of their time to research. Moreover, many of the non-university research institutions have a larger number of personnel than professorships at a university or *Fachhochschule*.

Table 12.2 Number of co-operation partners in all regions (median values)

	Universities	Fachhochschulen	Non-university research institutions
Hannover	7	3	14
Baden	7	-	12.5
Saxony	6	3	15
All regions	6	3	14

One focus of our analysis was the importance of spatial proximity between co-operating research institutions. Fig. 12.1 shows the spatial distribution of the collaboration partners. The spatial categories that were used to characterise the location of co-operation partners were the 'same region', the 'rest of Germany' and 'abroad'.[2] Regarding *university professors*, Baden is the region with the most

[1] Differences between the three regions are greater when the mean is used instead of the median. The mean number of co-operation partners at universities (*Fachhochschulen*) is 15.9 (9.3) in Hannover, 10.6 (-) in Baden and 6.9 (4.7) in Saxony. Due to resource restrictions no questionnaires were sent to *Fachhochschulen* in Baden.

[2] It should be noted that in each of the regions, the category 'same region' had to be defined individually. In Saxony the region is identical with the Federal State of Saxony while the

widespread research networks geographically. In Baden, on average 42 percent of all co-operation partners were located abroad. Though the share of regional partners was similar to that of the other two regions (32 percent in Baden versus 32 percent in Hannover and 31 percent in Saxony), co-operative relationships of university professors in Baden were less spatially concentrated, since in the Baden survey the category 'same region' comprises an area roughly twice as large as in Saxony and Hannover (see note 1 on previous page).

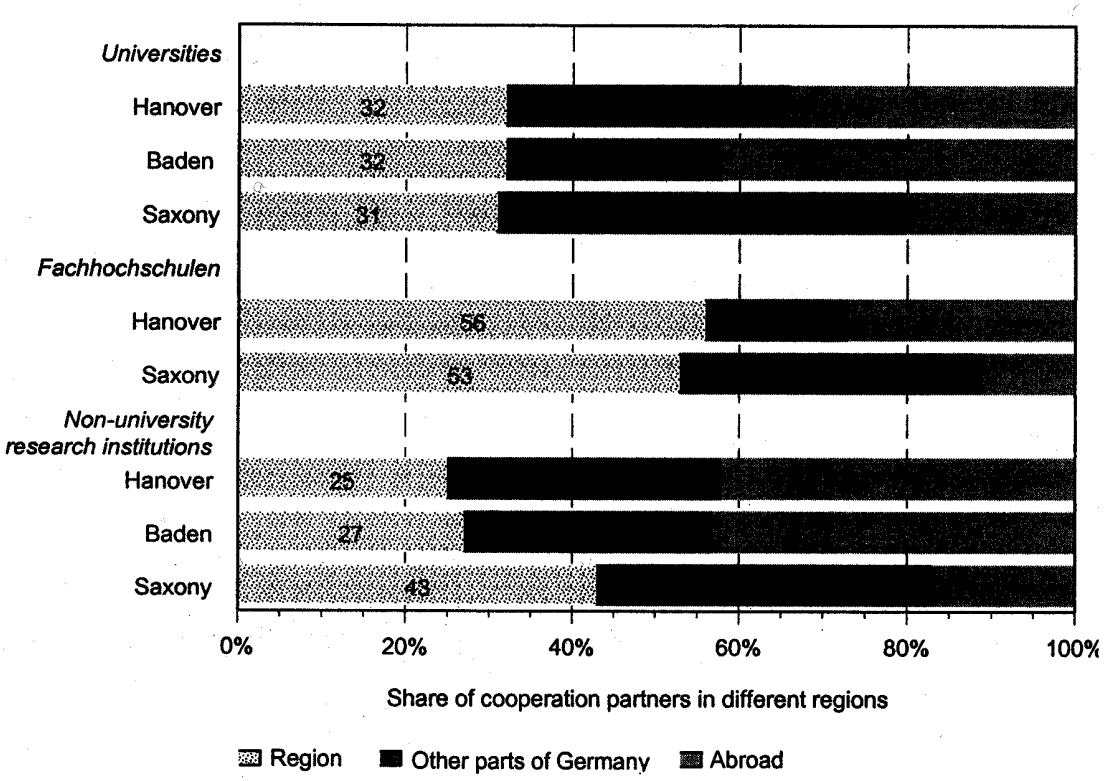

Fig. 12.1 Regional distribution of co-operation partners

The proportion of collaboration partners coming from within the same region was significantly higher in the case of *Fachhochschul* professors than university professors. More than 50 percent of the public research establishments which *Fachhochschul* professors collaborated with were located in the same region. The

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Hannover region (Hannover-Brunswick-Göttingen) constitutes only a part of the respective Federal State (Lower Saxony). These two regions are of roughly comparable size. Hannover-Brunswick-Göttingen (Saxony) accounts for 5.1% (5.6%) of the German population and 4.3% (3.1%) of the manufacturing employment in Germany. In Baden the 'region' was defined as the state of Baden-Württemberg. This area is considerably bigger than the other two regions. It comprises 12.6% of Germany's population and 18.3% of the overall manufacturing employment (see Niedersächsisches Landesamt für Statistik 1996).

share of foreign co-operation partners was also comparatively low. Of all types of research institutions, the *non-university research establishments* had the smallest proportion of co-operation partners located in the same region. The highest share of regional partners (43 percent) was found in Saxony.

Interestingly, in Saxony all three types of research institutions had a much lower share of foreign partners than in the other two regions. This indicates that Saxony's public research establishments are rather poorly integrated into interregional contact and research networks. A possible consequence is that the ability of the regional innovation system to absorb internationally available scientific and technological knowledge may be relatively weak. The relatively low percentage of professorships in Saxony that maintain co-operative relationships with research establishments located abroad suggests a similar conclusion. While in Baden, about 80 percent of all professorships at universities had at least one co-operative relationship with a foreign research institution, this proportion is only 61 percent in Saxony. A similar picture arises with regard to professors at *Fachhochschulen*. In Saxony only 34 percent of the respondents reported some co-operation with foreign partners, while in Hannover this share amounted to 45 percent. The sharpest contrast with regard to the existence of co-operative relationships to partners located abroad could be found among the non-university research establishments. In Baden and in Hannover, nearly all of the non-university research establishments maintain at least one such relationship to a foreign partner (92 percent in Baden, 91 percent in Hannover), while this share amounted to only 61 percent in Saxony.

Motives for Collaboration

According to our survey, co-operation among research institutions is not driven by a single dominant motive (see Table 12.3). Generally, we found only very small differences between the three types of research institutions concerning the motives. The most important reason for maintaining a co-operative relationship to another research establishments was to gain ideas for own research projects. More than half of the respondents (55.3 percent) declared this issue to be very important.[1] Gaining access to financial sponsorship tied to co-operation with other public research establishments was the second most important motive (29.6 percent). Interestingly, of all three types of public research institutions in our sample, non-university research establishments stated most often that this motive (financial sponsorship) played some role though only few respondents in this category considered this motive to be *very* important. Obviously, for most of the non-university research establishments, public financial sponsorship did not seem to be a primary source of motivation for establishing a collaboration with other research institutions.

[1] For each motive the respondents could choose between three possible answers ('disagree', 'agree', 'strongly agree') regarding the importance of a motive.

Table 12.3 Motives for collaboration with other research institutions

Motives for collaboration	Percentage of research institutions that 'strongly agreed' with the respective motive
Ideas for research work / thematic additions	55.3
Financial sponsorship only available for collaboration	29.6
Insufficient own equipment or budget capacity	23.7
Raising own profile	12.1
Others	8.3

Overcoming insufficient research capacities by collaborating with other public research establishments played a very important role in only one out of four cases and, thus, turned out to be less significant than expected. This motive was slightly more important for the *Fachhochschulen,* but differences between the three types of research institutions were essentially small. Raising the institution's own profile ranked fourth among all motives for establishing co-operation with other research institutions and was therefore the least important motive. However, one cannot completely rule out that in some cases the responses with regard to this motive do not reflect the whole truth, as some respondents might not have wanted to appear vain! Furthermore, in several cases, being well known might also be a prerequisite for an agreement on joint projects rather than one of its consequences.

Those research institutions that co-operated with other public research institutes were asked to estimate the intensity of this collaboration[1] according to the different types of partners. One of the partner types given in the questionnaire was an 'alliance of research establishments commonly sponsored by the European Union'. Correlation analysis between the type of collaboration partner and the motives for collaboration yields some interesting results (Table 12.4).

We found that the motive 'to gain inspiration for research projects' was significantly and positively correlated with the intensity of collaboration with other research institutions, but not with the intensity of co-operation within EU supported research alliances. Accessing financial aid is significantly and positively correlated with both types of co-operation partners, though the correlation is somewhat stronger for EU-funded consortia. To compensate for insufficient research capacities seems of relatively little importance for co-operation within alliances sponsored by the EU, since we found a significantly negative correlation coefficient for the relationship between the rating of this motive and the intensity of collaboration in an EU-sponsored framework. Interestingly, the respective coefficient of correlation is significantly positive for co-operation with other

[1] This estimation was made using a three grade scale ranging from 'hardly intensive' to "very intensive".

research institutions, indicating that these relationships are more appropriate for bridging resource gaps. No systematic relationship exists between the type of partner and the desire to become better known.

Table 12.4 Correlation coefficients between partner and reason for collaboration

	Alliance of research establishments sponsored by EU	Other research establishments
Importance of collaboration motive:		
Ideas for research work / thematic additions	0.01	0.21**
Financial sponsorship only available for collaboration	0.17**	0.11**
Insufficient own equipment or budget capacity	-0.10*	0.10*
Raising own profile	-0.02	0.08

Spearman rank-correlation coefficients, n = 560.
** statistically significant at the 1% level.
* statistically significant at the 5% level.

These results raise serious questions with regards to EU funding of research collaboration. Its aim is to make research more fruitful and productive by inducing co-operation, yet from our results it appears that such co-operation is mainly motivated by the availability of financial sponsorship and not by insufficient own capacity or the desire to gain additional knowledge on specific themes. On average, the co-operation induced did not help to overcome problems of insufficient capacity. Moreover, the scientific value added of EU sponsored co-operation appears to be rather low.

12.4 Conclusions

Our analysis shows that collaboration between research establishments is rather widespread, especially among university departments and non-university research institutions. A relatively high share of collaboration is located within the same region, indicating the importance of spatial proximity for establishing and maintaining co-operative relationships with other research institutions. However, a high concentration of co-operation partners within the same region may indicate a low degree of integration within international knowledge transfer networks and corresponding division of innovative labour. Therefore, the pronounced

concentration of co-operation with regional research establishments which we found in Saxony may work as a disadvantage for the innovation system there.

Furthermore our study raises some serious questions concerning the EU funding of international alliances of research establishments. As desirable as international co-operation might be, to stimulate such collaboration in a reasonable way seems to be a difficult task. Our analysis shows that co-operation within EU-supported research alliances is strongly motivated by financial considerations, while the exchange of ideas would seem to play only a minor role.

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