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On the explanation of horizontal, vertical and cross-sector R&D partnerships – evidence for the German industrial sector

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Abstract: This paper investigates the determinants of inter-firm cooperation in research and development (R&D). We analyse the impact of structural and firm specific characteristics, market performance, access to resources and managerial techniques on different types of inter-firm R&D cooperation. Based on a survey of 886 enterprises in manufacturing and industry/business-related services located in Germany, we estimate several models with different types of R&D partnerships as a dependent variable to find out which types of enterprises are more or less likely to form or join either type of R&D partnership. The findings suggest that the availability and the quality of a firm's own R&D resources are common factors driving R&D cooperation in general. Differentiating between cooperation activities in R&D among enterprises on the same production level on the one hand and vertical cooperation between enterprises and suppliers/customers or cross-sector alliances between enterprises and public research institutes on the other hand, we find cooperation type specific determinants of entry. The size of a firm, its location, access to financial resources and network experience seem to be most important.

Keywords: cross-sector alliances, inter-firm cooperation; R&D cooperation; SME.

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1 Introduction

The growth and prosperity of economies depend to a high degree on private investments in production capability. For many firms the production factor 'knowledge' plays a key role in their efforts to strengthen competitive capacity. Enterprises invest in research and development (R&D) to maintain and to improve their ability to compete. With growing global competition and shorter product life cycles many firms are searching for new ways to organise their innovation processes (Koleva, 2002). One approach to intensify R&D effort is to form partnerships with other firms or public organisations (i.e. universities) (Kaiser, 2001a). R&D cooperations range from periodical interactions to sharing knowledge and exchanging R&D personnel for conjoint projects up to founding R&D joint ventures. In such partnerships all participants work freely and mutually together without losing their economic independence. The aim of this paper is to identify the determinants for companies to participate in such R&D cooperations. Particular emphasis will be put on how pecuniary and non-pecuniary incentives promote R&D cooperation and whether government support for joint research activities is effective.

2 Literature and research question

Cross nationally a strong increase in the number of R&D cooperations can be observed in the last years. For Germany, König et al. (1994), for example find that while in 1971 only 10% of all manufacturing firms were involved in R&D cooperation, 20 years later the share rose to almost 50%. For the USA, Vonortas (1997), for example shows that a sharp increase in the number of R&D joint ventures can be observed. Despite this growth in practical relevance the theoretical and empirical analyses of R&D cooperation is still scarce (Kaiser, 2001a). Theoretical frameworks describing R&D cooperation have not been developed until the mid-1980s – even though John Kenneth Galbraith stated already in the 1950s that the era of cheap innovation was over and firms had to pool their R&D efforts in order to achieve scientific progress. Pioneering contributions on R&D investments with spillovers are the works of Brander and Spencer (1983); Katz (1986) and Spence (1986). A large strand of literature was built on these contributions (see for example D'Aspremont and Jacquemin, 1988, 1990; Geroski, 1995; Kaiser, 2001a,b; Kamien et al., 1992). However, even until today the main questions stayed

quintessentially the same (Kaiser, 2001a): (1) What determinants stimulate the formation of R&D cooperation? (2) Does cooperative R&D increase or decrease R&D efforts (Kaiser, 2001a)? Theoretically, the answer to these questions depends on two opposing effects: a positive internalisation effect and a negative competition or business stealing effect. Both go hand in hand with R&D spillovers between cooperating firms (D'Aspremont and Jacquemin, 1988, 1990). Theoretical and empirical papers within economics examine under which circumstance one effect dominates the other. Kaiser (2001a,b) for example gives evidence that:

- the more a firm invests in R&D, the more it can absorb from the partners' stock of knowledge
- an increase in market demand has a positive effect on research joint venture formation.

Cassiman and Veugelers (1999) find that firms with a large incoming spillover and lower outgoing spillover have a higher probability of cooperating in R&D. Kleinknecht and Reijnen (1992), who studied the determinants of research partnerships in the Dutch manufacturing industry, on the one hand find evidence that firm size does not have a significant effect on the propensity to cooperate. On the other hand, the existence of an R&D department, granted patents, licensing and sectoral affiliation significantly affects the probability to engage in partnerships. Röller et al. (1998) provide evidence that R&D cooperation is dependent on a number of industry-specific effects and that there is a tendency towards cooperation among firms with similar size.

Another important branch of research dealing with R&D cooperations is found in the strategic management literature. In contrast to the above-mentioned economic analyses, strategic management analyses draw heavily from sociological and psychological theories and are therefore much broader in scope. Cooperation among autonomous business entities is perceived as the most important instrument for value production in a global economy (Koleva, 2002). The evolution of cooperation is fostered by a common purpose, i.e. information and knowledge exchange, building up a competitive advantage, access or internalisation of new technologies and know-how beyond firm boundaries, realising economies of scale and scope, or sharing risk and uncertainty with the partners (Morris, 1998; Shiva Ramu, 1997). Thus, the central questions that are raised within the field of strategic management are very similar to the questions raised by economists; however, the analysis is different. At least three questions seem to be crucial:

- why do particular organisational forms of inter-firm cooperation occur and persist?
- what holds R&D partnerships together?
- is R&D cooperation always or equally favourable to the companies involved?

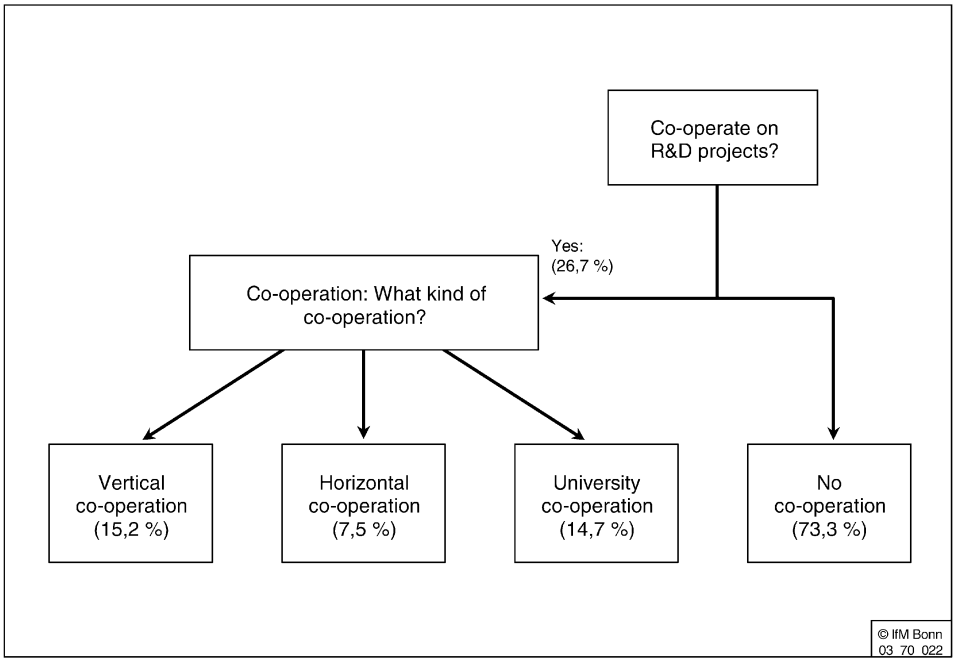
In this context, Gomes-Casseres (1996) emphasises that cooperation between firms also generates new forms of rivalry. All of a sudden business rivalry occurs not only between competing individual firms but also between allied firms. Podolny and Stuart (1995) present evidence that companies with a similar status level tend to engage in strong ties. Kogut (2000) shows that the emergence of certain cooperative organisational forms is contingent on specific industry settings. Walker et al. (1994) point out that cumulative commercial alliance patterns forecast a firm's future alliance patterns. Doz et al. (2000),

who analyse factors explaining R&D networks, conclude that especially initial conditions (i.e. environmental interdependence, formal structure) matter for the formation process. Furthermore, Chung et al. (2000) emphasise that resource complementarities, status similarity and social capital are the driving factors of cooperation between firms. For Eisenhardt and Schoonhoven (1996), cooperation results out of both rational business calculus and social calculus related to the skills, reputation and past relationships of top executives. Kogut (1991), on the other hand, points out that companies create research joint ventures in the case of a growing market. In contrast to the empirical findings, few authors have explicitly searched for a theory of inter-firm R&D cooperation (Koleva, 2002). One exception is the study of Kreiner and Schulz (1993). The authors investigated 16 successful university–industry cooperations, focussing on the personalised nature of R&D collaboration. The study uncovers how norms of reciprocity and liberally sharing information govern personal relationships. In addition, Dyer and Nobeoka (2000) give empirical evidence that management can create and govern rules and norms for sharing knowledge which promote efficiency gains. Furthermore, Isfan and Moog (2003) show that newly founded innovative firms are often born out of universities on the basis of R&D partnerships.

Papers with a strategic management perspective point out that the ability to manage inter-firm partnerships is particularly important. The management of partnerships is seen as being of central importance because building up relationships can produce strong lock-in effects (Koleva, 2002). Focussing on this aspect Kale et al. (2000) show that relational capital (based on mutual trust and interaction at the individual level) between alliance partners can enhance cooperative behaviour and mitigate competitive conflicts. Inkpen (1995) investigates how joint venture ownership can be legalised so that free rider problems do not occur in such partnerships. Lane et al. (2001) present empirical results demonstrating that management support and trust significantly influence the ability to understand new knowledge in international partnerships. Doz (1987) shows that successful alliance projects are highly evolutionary and go through interactive cycles of learning, re-evaluation and re-adjustment. However, despite these more or less stable empirical findings, there is only very scarce knowledge on the management of networks, alliances and joint ventures, i.e. on the factors driving the formation of R&D cooperation, on particular resource mobilisation strategies, and on firm or industry specific prerequisites (Koleva, 2002).

Thus, the purpose of our paper is to shed more light on the management of networks and their impact on success. Therefore, we will analyse enterprise and industry specific factors that stimulate the formation of R&D cooperations. Particular emphasis will also be put on the influence of knowledge management techniques and resource mobilisation strategies on the formation and persistence of R&D collaboration. Fortunately, we possess a unique data set which allows us to analyse a wide variety of hitherto unexamined determinants of R&D cooperation. Furthermore, with our data set we are able to examine separately the determinants of horizontal R&D cooperation (i.e. with competitors), vertical R&D cooperation (i.e. with customers and/or suppliers) and R&D cooperations between firms and universities.[1] Additionally, we focus on the question of whether government support has a traceable effect on the formation of R&D cooperations. This can be expected especially in Eastern Germany where government subsidy programmes on R&D research were implemented (e.g. InnoRegio) to equalise regional differences in efficiency.

Figure 1 Decision tree of choice between R&D cooperation partners



Note: Data are from the IfM Bonn Industrial Companies Study (BDI, 2001)

According to the questions raised from the literature, we will focus on the following issues:

- R&D cooperation as a means for enterprises to overcome size-specific entry barriers into R&D
- industry specific determinants of R&D cooperation (different types of cooperation)
- the influence of knowledge management techniques resource mobilisation strategies on the formation and persistence of (different types of) R&D collaboration.

In the next section, we firstly describe our data, a large representative sample of companies collected in the year 2001 by the Institute for Small and Medium Size Enterprises in cooperation with the German Federation of Industry (BDI, 2001). Secondly, we present some descriptive results on the characteristics of R&D cooperation in Germany. Thirdly, we present results from multivariate analyses. Finally, we summarise our findings and draw some tentative conclusions.

3 Data and descriptive results

To analyse R&D cooperation and its determinants, we use a random sample of 957 German firms out of which 886 provided information about their attitude towards R&D cooperation (for more details cf. BDI, 2001). The data were collected by the Institute for Small and Medium Sized Enterprises Bonn (IfM Bonn) for a project on family-owned

industrial enterprises in cooperation with the German Federation of Industry. The data cover companies in manufacturing and industry/business-related services such as credit and insurance industry or business and transport, communication and advisory services (without trade, catering and health services). Fortunately, the data set includes a broad set of variables that can be used to test the hypotheses on the evolution and persistence of R&D partnerships, covering structural and firm specific characteristics, market performance, access to resources, managerial techniques and a large number of typical control variables.

Descriptive analysis shows that 73% of the firms are not engaged in R&D cooperation, 7.5% cooperate horizontally, 15.2% work together vertically and 14.7% are involved in R&D partnerships with public research facilities (see figure 1). Overall, 38.0% of the companies involved in R&D cooperations have a high return on sales (i.e. more than 5%) whereas only 35.8% of the companies without R&D cooperation have a high return on sales. These results support the speculation from the theoretical literature that cooperative R&D increases R&D efforts. The result is backed by the finding that firms involved in R&D cooperation are characterised by above-average use of new technology, whereas firms not cooperating with other firms or research facilities are right on average (61.9% compared to 50.8%). Clear differences also exist between firms of different size, i.e. larger enterprises cooperate more often than smaller firms. The average firm size in our data set is 55 employees. Some of the firms (39.4%) above average size were engaged in R&D partnerships and only 21.4% of the firms below average were involved in such cooperation. And last but not least, there are clear regional differences: 81.3% of all firms were located in West and 18.7% in East Germany. Of the West German firms 27.6% were engaged in cooperative research (East German firms: 24.1%). However, in West Germany 96.2% of the firms were involved in R&D cooperation with other firms (i.e. horizontally and vertically) and 52.9% were cooperating with universities or public research institutes. In East Germany the share of cooperating firms with other firms is lower (88.4%) but the proportion of firms engaged in R&D partnerships with universities or public research institutes is noticeably higher (76.7%).

4 Determinants of R&D cooperation

To examine the circumstances under which enterprises are likely to form or join an R&D cooperation, logistic regressions for each type of R&D partnership were estimated separately: the horizontal, the vertical and the university/public research institute based cooperation. All regression models include the same set of dependent variables. However, since the regression results of the vertical model reveal no major differences to the results of the horizontal model, we will here concentrate on the comparison of horizontal cooperation (model A) vs. university based R&D partnerships (model B) to avoid unnecessary redundancies.[2] Based on the theoretical considerations introduced in Section 2, we expect that the formation of different forms of R&D partnerships depends on different goals or requirements of the respective firms, which in turn lead to differences in the positive internalisation and the negative competition or business stealing effect. Therefore, we expect systematic differences between regression model A and B. However, at the same time there may also be common factors driving any type of R&D cooperation; therefore we expect some variables to have a similar effect in both models.

Table 1 displays the results of maximum likelihood estimations on the formation of horizontal and university based R&D cooperations.[3] Firstly, we discuss the overall determinants of R&D cooperation, and secondly, we focus on particular determinants for a specific type of R&D formation.

Table 1 Logistic regressions: cooperation activities in R&D between enterprises on the same production level (regression model A) and cross-sector alliances between enterprises and public research institutes (regression model B)

Explanatory variables	*Regression model A* *'β'-significance coefficient*		*Regression model B* *'β'-significance coefficient*	
Structural characteristics				
Industry[a]: – Durable goods industry	0.563	0.389	0.802	0.227
– Investment good industry	0.194	0.740	–0.240	0.688
– Non-durable goods industry	0.821	0.195	0.080	0.902
– Construction	–0.387	0.676	–1.281	0.189
Number of employees in 2000 (log)	0.138	0.308	0.933	0.000 ***
Location of enterprise:1=Eastern Germany; 0=Western Germany	–0.106	0.835	1.032	0.028 **
R&D capacities/technological level of performance				
Use of new technology above branch average	0.302	0.388	1.103	0.003 ***
Share of R&D personnel on all employees	2.261	0.018 **	4.008	0.000 ***
Market performance				
Growth rate of employees 1999 till 2000	0.010	0.048 **	0.010	0.026 **
High percentage of return on sales	–0.505	0.172	0.255	0.502
Competitive situation				
Market share of primary product above average	0.334	0.352	0.496	0.187
Residence of main competitors in Germany	–0.996	0.004 ***	–1.148	0.001 ***
Financial margin for investments above average	0.233	0.500	–0.686	0.065*
Strategic management issues				
Company is lead by owner	–0.119	0.754	0.316	0.440
Experience in cooperation with other enterprises	1.169	0.002 ***	1.755	0.000 ***
Participative management style	–0.035	0.922	0.054	0.885
Teamwork is practised	0.285	0.408	–0.055	0.880
Employees have a share of the firm's profits	0.768	0.031 **	0.182	0.628
Management uses external consult services	0.621	0.075 *	0.756	0.038 **
Age of managing director (owner) of the firm	–0.037	0.041 **	–0.002	0.926
Model data				
Log-Likelihood	223.618	214.200		
Nagelkerke R^2	0.314	0.492		
Number of observations	389	389		

Notes: Significant at the 10 (*), 5 (**) or 1% (***) level
[a]reference category: industry related services

Source: Data are from the IfM Bonn Industrial Companies Study (BDI, 2001)

4.1 Overall determinants of R&D cooperation

With regard to structural characteristics, we find in all of our regression models that industry-specific circumstances do not seem to have a significant impact on R&D cooperation. Neither in the durable goods industry, nor in the investment- or non-durable goods industry, nor in construction is the probability of firms entering R&D cooperation significantly different from the probability in business related services. Thus, R&D cooperation seems to have become an instrument used alike in all industrial sectors in Germany.

Secondly, both models suggest that the *ex ante* availability of a company's own *R&D capacities* is a prerequisite to entering an R&D cooperation. A high share of R&D employees to total employees increases the likelihood of forming an R&D cooperation in both models. In contrast, enterprises without their own R&D staff rarely participate in R&D partnerships. These results indicate that the more research-intensive a company, the more it tends to also take advantage of external R&D capacities. Furthermore, it seems that only those companies who offer interesting knowledge to others can be assumed to find a partner from whom it can benefit and vice versa.

Thirdly, we will look at two variables that catch the effect of firm performance on the formation of R&D partnerships: the *rate of employment growth* and the percentage of *return on sales*. While growth rate has a significant positive impact on R&D cooperation in both models, return on sales does not have a significant effect. In other words: even enterprises with a temporarily negative return on sales are just as likely to enter R&D partnerships as enterprises in a prosperous market environment. This indicates that R&D cooperations are not planned based on short-term market performance but rather on long term considerations as indicated by the positive impact of employment growth. Since there is very high employment protection in Germany, hiring new employees can be interpreted as a sign of prosperous market expectations.[4] To summarise: The often heard hypothesis stating that mainly troubled enterprises seek help in R&D by joining cooperations while those with good market expectations do not require this type of support, cannot be confirmed.

Fourthly, in both models we find similar evidence that enterprises with a *market share* above average are not more likely to join an R&D cooperation than those with a relatively lower share. Even firms operating in a market niche participate in both forms of R&D partnerships. An additional, very interesting, result is the relation of the competitors' and cooperators' home bases. Companies which compete mainly with firms not located in Germany (as compared to those competing mainly on a national level) are more likely to join R&D cooperations. Evidently, a common cooperation strategy seems to be: 'competing on an international scale and cooperating on a regional scale'.[5]

Fifthly, with regard to ownership, we find that companies managed by their owners have the same probability of entering both types of R&D cooperations as companies managed by managers. However, having *past experience with cooperation* increases the likelihood of R&D cooperation. This result is backed by findings of Wolff et al. (1994) who suggest that dealing with R&D cooperation is learnable. Companies with past experiences know better what to take into account when choosing a new partner. However, another explanation for this finding is that there are more opportunities to cooperate in R&D in companies that know partners from earlier cooperative relationships. Being part of a network provides necessary contacts and may open doors easily for new partnerships. Knowing each other on a personal basis already offers security and makes

it easier to convince a partner to enter a new project. Opportunities for R&D cooperation might even directly develop out of existing cooperations in other fields. And a trustful relationship built up during past cooperative projects often provides the basis for a partnership in core business areas such as R&D.

Last but not least, we find that a *participatory style of management* and *teamwork* do not have a significant impact on the likelihood of R&D cooperation. Enterprises that organise parts of their production in teamwork and/or manage their company in a participatory style are not cooperating more often than others. However, companies using *external consultant services* have a significantly higher probability of being engaged in R&D cooperation.

4.2 Type-specific determinants of R&D cooperation

In addition to the overall determinants of R&D cooperation that we observed in the previous section, there are a number of determinants that foster either horizontal or university/public research institute cooperation.

Firstly, the *size of the enterprise* (measured by the number of employees in the firm) has a significant impact on the type of cooperation chosen. While cross-sector alliances between university research institutes and private companies are significantly more likely to be formed for large companies, horizontal cooperation is realised alike by enterprises of all sizes. One possible explanation for the higher likelihood of cross-sector alliances for larger companies is that the type of research conducted in such cooperations may be mostly basic research. Since basic research is often expensive, includes higher risks and needs a long time before it pays off, it is probably less attractive for smaller companies who cannot diversify their risk. Therefore, larger firms may be considered to be a more adequate partner for universities looking for R&D cooperation.

Secondly, and in line with the above finding, we observe that using *new technology above industry average* has a significant positive impact on cross-sector R&D cooperation. Enterprises that participate in R&D cooperation with universities/public research institutes consider themselves to be better equipped with new technologies than others. More new technology on the other hand is likely to go together with special knowledge, which is an important condition for R&D cooperations as shown in the section above.

Thirdly, we find differences between the type of R&D cooperation and the *firm's location* (i.e. East Germany vs. West Germany). All else being equal, the probability of cross-sector cooperation is significantly higher for companies in Eastern Germany than in Western Germany. Thus, the multivariate results confirm the descriptive finding of Section 3 for cross-sector cooperation. However, there are no regional differences with regard to horizontal R&D cooperation. Our speculation is that this is due to government programmes subsidising R&D. For more than a decade, the main objective of all kinds of innovation and research government programmes was to support the transformation process in Eastern Germany.[6] Due to the fast integration of eastern companies into the western market economy, most of the large old production plants were not competitive and were closed down or had to downsize dramatically. Therefore, one of the aims of governmental policy was to support the development of new core industries. Various measures had been taken to stimulate research in the private sector: in order not to lose business know-how after closing so many production plants, public research entities were

created to preserve former knowledge and to carry on research. Additionally, enterprises in Eastern Germany are supported by financial aids (DIW, 2001),[7] and firms received governmental subsidies to employ R&D personnel, which was quite effective.[9] In addition to subsidising the enterprises' own R&D activities, governmental policy aimed at tying enterprises together in order to pool resources and to support transfer of knowledge. An interesting measure in this regard was the InnoRegio contest, a programme explicitly created for Eastern German states (BMBF/ BMWI, 2001, p.31). In order to get support from this programme, enterprises had to create innovative networks between enterprises including – if possible – public institutes. Therefore, the fact that especially cross-sector alliances can be more often observed in the eastern part of the country indicates that governmental policies were quite effective in this regard. Enterprises with residence in Eastern Germany obviously use more knowledge spillovers from public research institutes than their counterparts in Western Germany. Therefore, encouraging enterprises to form network alliances to build up new competences seems to be one way to overcome structural problems (see also DIW, 2004).

Last but not least, estimation results show that the probability of firms cooperating horizontally (i.e. with potential competitors) is significantly higher if *profit sharing* is used in the firm. This pattern is easy to explain by standard incentive theory (see e.g. Baker et al., 1988; Milgrom and Roberts, 1992): if the pay of managers and qualified workers in R&D depends on profits, they all have an incentive to ensure that research results stay within the firm so that profits as well as individual income is at a maximum. Thus, profit sharing minimises the risk that the cooperation partners get away with stealing business ideas or all other kinds of opportunistic behaviour via intensified monitoring. Since the competition effect is primarily dominant in the case of horizontal R&D cooperation, it is at the same time not surprising that profit sharing has no significant effect in the case of cross-sector cooperation with universities or public research institutes.

7 Summary and conclusions

The research reported here suggests that in the case of the industrial sector in Germany, R&D cooperation seems to be a largely successful measure for enterprises to improve their innovation performance. Firms participating in an R&D cooperation are usually characterised by a relatively modern range of products and services. R&D cooperation has become a widely used strategic measure of innovation management. Several regression models were estimated to analyse the determinants of different forms of R&D cooperation, i.e. horizontal, vertical and university or research institute based cooperation. Our findings suggest that the likelihood of an enterprise to become partner in a horizontal or vertical R&D cooperation depends significantly on its *ex ante* R&D capacities as well as on its experiences in other forms of corporate partnerships (in less sensitive business fields). As regards cross-sector R&D cooperation, we find that the larger, well equipped firms with more financial resources, i.e. above industry average, have the highest likelihood to be accepted as a research partner. However, among smaller enterprises with a limited capacity, cooperations can also help to diminish size specific disadvantages in R&D. They choose inter-firm cooperation more often to share risks, save costs and pool know-how.

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Notes

[1] Since some firms may be involved in both horizontal and vertical R&D cooperation, a mixed mode-category exists. For results on the decision to form a mixed cooperation see Kaiser (2001b).

[2] Table A1 in the appendix displays the estimation results for the determinants of vertical R&D cooperation.

[3] In the questionnaire companies were asked whether they were or are involved in a horizontal, a vertical or a university based R&D cooperation. Thus, we have three binary dependent variables and estimated three alternative binary logistic regression models.

[4] With the exception of vertical cooperations, R&D cooperations are set up by growing enterprises more often than by those with stagnating or even diminishing numbers of employees.

[5] Unfortunately we can not provide information about the residence of the partners of those in the sample who cooperate. Therefore this assumption is only of hypothetical nature.

[6] As the Federal Statistics Office pointed out for the year 1999, the so-called 'new federal states' in the Eastern part of Germany are still lagging behind and show a productivity that hardly comes up to 65% of the Western German level (Statistisches Bundesamt, 1999). This indicates that the Eastern German economy is still on its way to recovery from the transformation process that started with the collapse of the communist regime and the establishment of a free-market economy. As far as the use of new technology is concerned, significant differences between the companies in Eastern and Western Germany can not be found. Pohl (2002) also states that the capital fund has been largely replenished.

[7] Other policy measures such as promoting corporate alliances, providing relevant information, setting up and developing initiatives or mediating between potential partners, cannot be discussed in the following discourse. Even though they represent promising means as well, they can not be accounted for in this study.

[8] According to the findings of ZEW (2003, p.16), the share of enterprises involved in R&D is now slightly higher in Eastern Germany (27%) than in the western part of the country (23%). Another policy aims at increasing the firm's absorptive capacity in terms of knowledge transfers.

Appendix

Table A1 Logistic regressions: vertical cooperation activities in R&D between enterprises and suppliers or customers (model C)

Marks	*Regression model C*	
	'β'-coefficient	Significance
Structural characteristics		
Industry[1]:– Durable good industry	0.573	0.367
– Investment good industry	0.202	0.718
– Non-durable good industry	0.438	0.467
– Construction	–0.895	0.327
Number of employees in 2000 (logarithm)	0.193	0.170
Residence of the enterprise: Eastern Germany	0.150	0.741
R&D capacities/technological level of performance		
Use of new technology above branch average	0.361	0.297
hare of R&D personnel on all employees	3.149	0.004***
Market performance		
Growth rate of employees 1999–2000	0.008	0.112
High percentage of return on sales	–0.272	0.443
Competitive situation		
Market share of primary product above average	–0.151	0.666
Residence of main competitors in Germany	–0.974	0.004***
Financial margin for investments above average	0.398	0.246
Strategic management issues		
Company is lead by owner	–0.272	0.472
Experiences in cooperation with other enterprises	1.330	0.000***
Participative management style	0.281	0.433
Teamwork is practised	0.132	0.707
Employee have a share of the firm's profits	0.703	0.055*
Management uses external consult services	0.465	0.157
Age of managing director (owner) of the firm	–0.032	0.085*
Model data		
Log-likelihood		282.56
Nagelkerke R^2		0.351
Number of observations		389
		(c) IfM Bonn

Notes: [1]Significant at the 10% (*) , 5% (**) or 1% (***) level
[2]Reference category: industry related services

Source: Data are from the IfM Bonn Industrial Companies Study (BDI, 2001)