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Working Paper

Success potential of international R&D cooperations

Manuskripte aus den Instituten für Betriebswirtschaftslehre der Universität Kiel, No. 299

Provided in Cooperation with:
Christian-Albrechts-University of Kiel, Institute of Business Administration

Nr.299

Success Potential of International R&D Cooperations

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November 1992

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I. Background and Objectives

Cooperation in Research and Development constitutes a new phenomena both for managers as well as for management scientists. Starting in the early Eigthies there has been an immense growth of such cooperations between single - even competing - enterprises (Hagedoorn, 1991). By pooling resources and realizing synergies firms try to gain various positive effects as e.g. generation of new ideas, saving of time and costs or reduction of risks (Rotering, 1990). However, cooperations also encounter potential pitfalls caused by opportunistic behavior of the partners who remain independent and who pursue foremost their own interests (Bresser, 1986). The variety of arguments in favor of and against R&D-cooperations as well as the spread of de-facto successes and failures show the high complexity of the issue (Hagedoorn, Schaakenraad, 1990). Due to the novelty of the phenomena, an integrated theoretical model explaining success or failure has not been developed by now. The explanatory approaches derive from different theoretical disciplines, their conclusions are in part complementary, and in part they are controversial.

This study tries to integrate key elements derived from theory. Arguments in favor and against R&D cooperation will be analyzed simultaneously. We want to explore the relative importance of the key variables that may determine the success potential of cooperative R&D agreements as well as their interaction effects. This will be achieved by a conjoint analysis.

II. Hypotheses

In the following, five key criteria for cooperation success are extracted from theory and from empirical evidence: Project Outcomes, Strategic Mission, Cost Advantages, Specialization of Partners, Relationship of Partners. A large amount of research work exists on these key variables. This work will be sketched only very roughly. Each variable may be derived from game theory, transaction costs theory or from theory regarding the strategy of the firm. Their empirical foundation is shown by an analysis of existing empirical work. From theoretical and empirical evidence working hypotheses are generated.

A. Project Outcomes

Classifying R&D projects by type of technological outcome, one usually distinguishes between those projects leading to precompetitive results and those leading to marketable outcomes (Shapiro, 1985). The first type is more related to basic research and is more distant to commercial applications. It is characterized by gaining of broad knowledge, not restricted to one specific usage. The second type aims at embodying the findings into a specific product or process. Precompetitive research has a lower possibility of exclusive usage (i.e. lower appropriability) due to its missing specifity and its public character. This leads to potential underinvestments in those areas and makes cooperation worthwile from a public point of view (Nelson et al., 1967; US-Department of Justice, 1980). However, from a management point of view precompetitive cooperations are not necessarily preferred:

Game theory remains ambiguous about this topic. Marketable outcomes could be preferred because of their higher appropriability and saleability (Sinha and Cusumano, 1991). On the contrary, basic research creates a wider spread of possible application and involves less danger of controversies over specific uses. The probability of gain-gain situations is higher, which favors cooperating in basic research.

From a strategic point of view application oriented cooperations might be more preferable. Basic research appears to be closer to the sensitive technological 'core' of an enterprise and it is therefore preferably performed in-house (Harrigan, 1985). Research on marketable products in the long run causes less danger of strategic inflexibility. It faciliates a clearcut separation of activities (Porter, in: Wolff, 1989). However, practitioners' experiences contradict this expectation (EIRMA, 1989, pg. 14). There is no empirical evidence on the favorability of any one outcome type of cooperation. Successful cooperations exist in each stage of the technological life cycle (Chesnais, 1988, Brockhoff, 1990). This leads to the following hypothesis:

H_A: *R&D cooperations are as well suited for precompetitive research as for obtaining marketable products.*

Since the two outcome types cause different requirements one can assume that favorable cooperations look somewhat different for each of those two output types. Therefore, interaction effects with the other variables are expected (see discussion below).

B. Strategic Mission

R&D projects may aim at supporting an area of existing core technologies or aim at building new areas of competencies.

Theory unequivocally favors cooperations with the mission of building new areas of competencies. Transaction costs theory stresses the high costs of building such new competencies internally (Pisano, 1990, p. 161). Strategic literature emphasizes the risk of disfunctional effects within core areas. Thus it is necessary to protect the 'technological core' from the environment (Harrigan, 1985; Teece, 1986 and 1988).

Practitioners seem to favor R&D cooperation as interim solution for entering new markets or technologies. This can be read from the following quotation: "During (a) period of rapid expansion, R&D cooperation with outsiders was often necessary in areas where in-house R&D may be preferred after a period of consolidation." (EIRMA, 1989, p. 18).

These observations are been supported by empirical evidence (Pisano, 1990; Wolff et al., 1991). According to these findings, cooperation activities decrease with increasing strategic importance or familiarity with the technological area. This leads to following hypothesis:

H_B: *Companies favor to cooperate in projects aimed at generating new areas of competencies versus enhancing their existing core technologies.*

C. Cost Advantages

Without any doubt the achievement of cost reduction is a key motive for R&D cooperations. Sinha and Cusumano (1991) within their game-theoretical model denote three out of eight hypotheses to the cost effect. The minimization of cost is also seen as a mandatory element for achieving strategic advantage on an highly competitive, global market (Ohmae, 1985, Katz, 1986).

Empirical evidence supports the relevance of this variable. Within a large empirical study of national R&D cooperations, cost advantages were classified as the second most important factor of such joint activities (Rotering, 1990).

H_C: *The higher the expected cost savings, the more preferable is a cooperative project.*

The cost sensitivity might be depending on the type of technological outcome. The danger of underinvestments into basic research has been stated already. This might be enforced by the high uncertainty of achieving usable outcomes. Therefore firms might be especially interested in sharing the burden of cost-intensive basic research (Hagedoorn, Schaakenraad, 1990, p. 77). This suggests an interaction effect between the variables 'project outcomes' and 'cost advantages':

H_{AC}: *The size of expected cost savings is more important for precompetitive projects than for those aiming at marketable outcomes.*

D. Specialization of Partners

The degree of specialization measures the extent of interorganizational division of labour within a cooperation. Partners with high specialization may supplement each other in their strengths if they possess complementary skills and resources.

Innovation theory stresses two trends of the technological development: increased complexity and interdisciplinarity. The necessity of considering a wide range of technologies rises. Even for large MNE's it becomes impossible to achieve leading-edge positions within all of the relevant technological areas (Fusfeld, Haklisch, 1985, p. 70; Häusler et al, 1991, p. 10). Access to complementary skills and resources of other organizations thus becomes necessary. Strategic literature states this as the most prominent motive for cooperating (Harrigan, 1985; Imai, Nonaka and Takeuchi, 1985). Even transaction cost theorists devote attention to this motive (Teece, 1986 and 1988; Dobberstein, 1992).

Empirical studies unequivocally support the motive of utilizing complementary skills and resources as a key motive for cooperations (Mariti and Smiley, 1983; Willinger and Zuscovitch, 1988; Rotering, 1990; Wolff et al., 1991). We therefore have to include the following hypothesis within our analysis:

H_D: *Cooperating companies prefer partners with complementary skills and resources.*

According to transaction cost theory, the complementarity of skills and resources is especially useful in those areas which are characterized by a high diversity of tasks - i.e. activities outside of the core technologies. Only if those two conditions are simultaneously met, cooperations represent an adequate mode of organization (Richardson, 1972; Weder, 1989).

From a strategic perspective, the required degree of specialization depends on the strategic mission: Cooperations with complementary partners serve the deployment of internally not accessible skills and resources. Market- or technology-entering partners achieve high 'leapfrog'-advantages (Link, Bauer, 1989) by cooperating. This leads to:

H_{BD} *The entering of new areas of technology is a favorite goal of cooperations with partners that command on complementary skills.*

E. Relationship of Partners

While there are many possible ways of classifying relationships between partners, perhaps the most important way is the differentiation between competitors and non-competitors. According to transaction cost theory the probability of opportunistic behavior increases with the degree of competition between the partners. Cooperations between competitors require safe guards and cause higher transaction costs (Hennart, 1988). Strategic literature shares this view based on a similar argumentation: Competition between partners causes potential areas of conflict, leading to higher instability (Kogut, 1988).

Companies state in general that they prefer to join forces with non-competing partners (Rotering, 1990). This gives rise to:

H_E: *Cooperations between non-competing firms are preferred.*

However, while companies prefer to cooperate with non-competitors, they are engaged in joint activities with competitors as well: The majority of empirical studies (Rotering, 1990, p. 99) show even a majority of horizontal cooperations, which possess a higher exposure towards competition than vertical cooperations. Therefore, a more differentiated view on the effects of competition is required, taking interaction effects with other variables into account. As will be shown below, competition between partners is less relevant for precompetitive projects, within new areas of competencies and encountering high cost advantages:

Within precompetitve research areas, outcomes are less specific and can be used simultaneously by all partners. This leads to more gain-gain situations. On the contrary, projects aiming at marketable products are more likely to lead to zero-sum games due to distributional fights (Willinger and Zuscovitch, 1988, p. 287).

The findings of Rotering (1990) support this type of interaction effect. He showed that horizontal cooperations concentrate more on precompetitive research while vertical cooperations favor research on marketable outcomes. Rotering finally distinguished five types of cooperating firms, the most successful being the 'single-partner, vertical cooperating firm in research and production'; another the 'intense horizontal cooperating firm within basic research'.

H_{AE} *Cooperations with competitors are less favorable for projects aiming at marketable outcomes than for projects in the field of precompetitive research.*

Within new areas of competencies, less competitive information is accumulated in-house. Within those areas, transfer of technology and organizational learning is not seen as a disfunctional effect but is encouraged from a business point of view. Japanease firms pursue successfully this active strategy of entering new markets and technologies by cooperating (Ciborra, 1991).

H_{BE} *Cooperations with competitors are more preferred for the entering of new areas of competencies than for enhancing the existent core technologies.*

High cost advantages may convert a zero-sum game into a gain-gain situation. Controversies on outcomes are less fierce if all partners can achieve a high amount of cost savings. This is especially true in markets where there is high competitive pressure from the outside (Link, Bauer, 1989, p. 50). Rotering (1990) found a higher importance of cost effects for horizontal cooperations than for vertical cooperations.

H_{CE} *With increased cost savings, cooperations with competitors appear to be more favorable.*

In the following we want to test the above hypotheses.

III. Methodology

An empirical investigation is performed addressing participants of European cooperative R&D projects of the ESPRIT and EUREKA type. The survey is designed as a conjoint measurement experiment: Potential cooperative agreements are described; interviewees are asked to rank order them by a holistic evaluation according to their preference. From this information, preference functions are estimated. The relative importance of the variables and of their interaction effects is evaluated as well on an individual as on an aggregate level. This is the method of Conjoint-measurement. It is a decompositional experimental design which is widely used in marketing.

The conjoint-analysis consists of several steps. First the variables have to be specified. Than the experimental design has to be chosen. Within the experimental survey the interviewees are confronted with a set of scenarios which they have to rank according to their preferences. By decomposing one obtains the individual preference functions which can be aggregated.

Conjoint-measurement fits best for the purpose of this study for two reasons:

- The experiment is especially suited for this restricted set of interrelated factors. It allows one to create an empirical design tailored to the stated hypotheses. Thereby it is possible to control and evaluate not only individual variables but also its interaction effects. Trade-offs can be quantified.

- A decompository approach fits the real-life decision making process. In the case of R&D cooperations, decision makers are confronted with a complex, highly uncertain subject. Not all functional and disfunctional effects can be anticipated. Therefore it may be assumed that decision makers base their decisions on a holistic assessment. Traditional questionnaires do not recognize this because they are based on an evaluation of individual items.

Deduction of variables: The variables are derived directly from the hypotheses. They meet all necessary conditions for using them in a conjoint-analysis (Weisenfeld, 1988, pp. 97ff.):

- The variables are relevant and discriminating. Their theoretical and empirical relevance is demonstrated. Within an initial survey it has been checked that the perception of scenario descriptions fits the intended values of variables.

- The variables have independent contents. If variables would measure related issues, a separate evaluation were not possible due to redundancy effects.

- The set of variables is sufficiently small. Greenhalg et al. (1978) recommend an upper threshold value of 7 variables based on reliability considerations.

Dichotomous levels are chosen for each variable in order to control the complexity of the experimental design. Although this approach does not reveal non-linearities, it provides robust estimates (Weisenfeld, 1989, p. 62) and it is widely used (Louviere, 1988, p. 34, Schrader, 1990). The resulting design looks as follows:

#	Variable	Value K (-1)	Value L (+1)
A	Project Outcomes	precompetive research	marketable product
B	Strategic Mission	enhance core technology	build new areas of competence
C	Cost Advantages	minor savings	major savings
D	Specialization of Partners	similar skills resources	complementary skills/ resources
E	Relationship of Partners	non-competing firms	competing firms

Fixing of Design: A set of five variables with two levels each leads to a full factorial design of 32 scenarios. Such a large number of scenarios would overstress the interviewees and reduce the reliability of results. Therefore a systematic reduction of scenarios (Weisenfeld, 1989) has been performed. A pure orthogonal design would lead to a confounding of main effects and interaction effects (Louviere, 1988, p. 41). Thus, the expected interaction effects are taken into account.

The selected subset consists of 16 scenarios, with which all main effects and all possible two-factor interactions can be evaluated (Hahn, Shapiro, 1966). Assuming just two relevant interaction effects within an individual observation and no higher-factor interactions, eight degrees of freedom remain. A common deficiency of Conjoint studies - too small or no degrees of freedom - is omitted (Green, Srinivasan, 1990, p.5).

Four additional scenarios are included as hold-outs. Those scenarios are not used for the estimation of the preference functions. They serve as a proof of external validity by comparing their actual versus their predicted preference values. Altogether, a set of 20 scenarios results. This is within the commonly used range (Weisenfeld, 1989, p. 62).

Execution of experiment: Interviewees are European participants of international R&D cooperations within the ESPRIT- and EUREKA-agreements. They are R&D-managers who are directly confronted with cooperation processes and who are responsible for cooperation decisions. They can be classified as cooperation experts.

The experiment is conducted by mail. Subjects are given twenty scenario cards in random order with a varying sequence of variables (see example in Figure 1). They also receive a brief one-page description of the exercise (see Figure 2). The subjects are asked first to classify the cases using three categories and secondly to rank order all scenarios according to their preference. 140 questionnaires were mailed, 81 responses were received of which 75 are included in the following evaluations.

Figure 1: Example of a scenario card

ASSESSMENT (see Instructions)

➔ **Step 1: Sorting**

Would you favor this cooperative project?
Check the appropriate category

○ No ○ Maybe ○ Yes

➔ **Step 2: Ranking**

In comparison to the other cases,
how would you rank this case?

(please put ranking number of this case here)

1: least favorable ... 20: most favorable

Case 6

Background Information

Strategic mission	**enhance core technology**
Project outcomes	**precompetitive**

Cooperational features

Specialization of partner	**similar skills/ resources**
Cost advantages	**major savings**
Relationship of partners	**non-competing firms**

Figure 2: Scheme of instructions

INSTRUCTIONS for Ranking the Cards

This experiment is to simulate decision-making situations.

Consider the following situation: A colleague from your company calls you up. For several reasons, he is interested in 20 possible, quite large international R&D cooperations.

You are asked to rank these projects. The project backgrounds are listed on the enclosed cards.

Please rank ALL cases.
Do NOT omit any.

Step 1: Sorting all cards

Please look at one card at a time. Decide if you would favor the described project. Check one of the following three categories on the index card and sort them accordingly:

○ No ○ Maybe ○ Yes

➔ First sort all 20 cards. Then proceed with Step 2.

Step 2: Ranking all cards

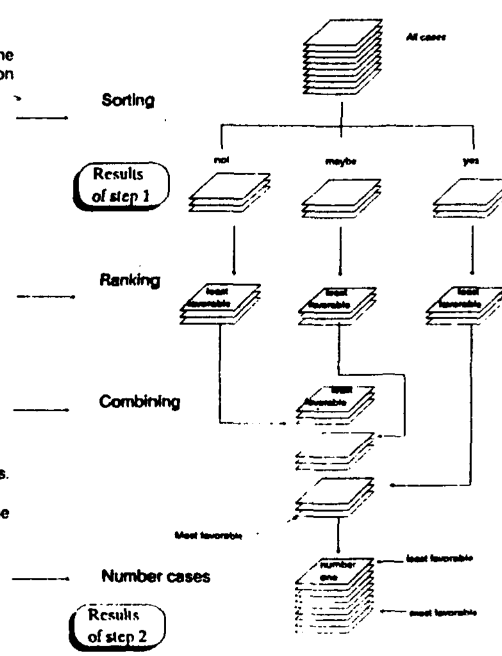
2.1 Rank projects within each of the three piles.
The *card on top* should contain the case which you *least favor* (of all cases in the pile).

2.2 Combine all three piles into one deck as shown.
You obtain an entire ranking according to increasing preference.

2.3 Number the index.
Please check if you are satisfied with the entire sequence of the cards.
Put the ranking numbers on the index cards or write them down.
The case which you least favor should receive rank '1', the next one rank '2', ...

(please put ranking number of this case here)

Scheme of Instructions



Please indicate finally whether you see possibilities for improvement.

Method of evaluation: Following the collection of data, a model has to be generated that relates variable levels to preference. The most common model used in the conjoint analysis is the additive compensatory model of main effects. For this study, it has been extended by the inclusion of interaction effects.

For the generation of the interaction effects, dummies have been included as additonal quasi-main effects in the model (Green, 1984; Louviere, 1988). The value of a dummy is the cross-product of the sign-values ("-1" for value K; "+1" for value L) of its main effects. For example, the combination of variable level A: "precompetitive research" and variable level E: "competing firms" leads to the dummy level AE: "value K" (cross-product of: (-1)*(+1) = -1).

Individual preference functions are obtained using multiple regression with effect-dummies (the underlying method of SPSS-Conjoint). A preference function consists of an addition of part-worths for the individual variables. Part-worths are positive, if variable level 'K' (see description of design on page 7) is preferred, otherwise they are negative. The preference functions are normalized so that the sum of the absolute values of the part-worths adds up to 100%.

The individual preference functions are subsequently analyzed on an aggregate level - using the robust methods of descriptive statistics as well as by classifying the data using clustering techniques, where appropriate.

IV. Findings

An overview of the individual preference functions is presented in table 1. With the exception of the variable "strategic mission", the hypotheses on **main effects** are supported by the data: As expected from hypothesis H_A, the mean value given to variable "outcome" does not deviate significantly from zero. This implies, that both precompetitive research works and marketable outcomes are considered as feasable outcomes for cooperative research projects. The negative average values of the variables "cost advantages" and "specialization" indicate that the levels 'L' are preferred, which corresponds to projects characterized by "high savings" and "complementary skills and resources". This supports the hypotheses H_C and H_D. The large positive part-worth assigned to "relationship" shows the strong preference for joint projects with non-competitors, supporting hypothesis H_E.

A comparison of the absolute size of the mean part-worths reveals information about the relative weight of the variables: On average, the size of expected cost savings is of highest importance for the evaluation of a cooperation. Somewhat less emphasis is placed on the potential disfunctional effects caused by cooperating with competitors. The potential benefits from pooling complementary skills and resources are graded as second-rated: the weight which is been given to "specialization" is around half as high as the weight given to cost considerations.

Table 1: Normalized part-worths of the individual utility functions1

	Mean	Standard Deviation	Maximum	Minimum
Outcome	-.03	.22	.52	-.54
Mission	.03*	.15	.50	-.35
Cost Advantages	-.24**	.14	.02	-.55
Specialization	-.09**	.11	.12	-.52
Relationship	.18**	.16	.55	-.11
Outcome*Mission	.01	.11	.23	-.14
Outcome*Cost	.01*	.09	.20	-.12
Outcome*Specialization	-.00	.10	.14	-.21
Outcome*Relationship	.03**	.10	.33	-.12
Mission*Cost	-.00	.07	.07	-.09
Mission*Specialization	.00	.10	.26	-.11
Mission*Relationship	-.00	.08	.12	-.18
Cost*Specialization	-.00	.11	.18	-.22
Cost*Relationship	.01*	.08	.19	-.08
Specialization*Rel.ship	.00	.09	.14	-.13

1) Part-worths are positive, if variable level K is preferred, otherwise they are negative.

**) Mean is highly significant different from 0 (t-test with alpha=0.01)
*) Mean is significant different from 0 (t-test with alpha=0.05)

The variables "Outcome type" and "strategic mission" possess on average a negligeable part-worth. This results from conflicting utility functions: Individual preferences range from a strong favoring of "conduct precompetitive projects" or "enhance core technologies" (=maximum part worth larger than 0.5) to a strong favoring of "achieve marketable outcomes" or "build new areas of competence" (= minimum part worth smaller than -0.3). This shows that different strategies are pursued for those two variables.

The **interaction effects** contribute far less to the overall preference than the main effects. Their variance is in general too high to draw conclusions. The three interaction effects which possess a mean value significantly different from 0 are of meaningless size. This does not mean that one should neglect those effects. Looking at the disaggregated individual preference functions, the main effects account on average for around 80% of the explained variance; the two-factor-interactions account for up to 50 % for some observations.

To shed some more light on this issue, table 2 provides a more robust list on the count of significant effects. It can be seen that the interaction effects occur only in subsets of the data. While main effects on average show to be significant in 3 out of 4 observations, interaction effects tend to be significant only in 1 out of 5 observations. Different respondents include different interaction effects into their evaluation. In this sense, cooperation strategies seem to differ for all interaction effects.

Table 2: Frequency of preferred variable levels

	Number of observations (total=75) with preference for			corresponding hypothesis
	value L	indifferent	value K	
Outcome	29	27*	19	H_A
Mission	17*	30	28	H_B
Cost Advantages	69*	6	0	H_C
Specialization	40*	31	4	H_D
Relationship	3	16	56*	H_E
Outcome*Mission	11	53	11	
Outcome*Cost	1	67	7*	H_{AC}
Outcome*Specialization	9	61	5	
Outcome*Relationship	6	43	26*	H_{AE}
Mission*Cost	5	66	4	
Mission*Specialization	8*	58	9	H_{BD}
Mission*Relationship	10*	58	7	H_{BE}
Cost*Specialization	9	59	7	
Cost*Relationship	8*	53	14	H_{CE}
Specialization*Rel.ship	7	60	8	

*) expected preferences

Restricting the viewpoint to observations in which the individual interaction effect appears to be relevant, one can extract tendencies for three interaction effects: The interaction effects "Outcome*Costs" and "Outcome*Relationship" occur as expected from hypotheses H_{AC} and H_{AE}. If companies cooperate in precompetitive research (level 'L' of variable "Outcome"), the aspect of cost-saving becomes more important and the fear of cooperating with competitors decreases (level 'K' of variables "Costs" and "Relationship"). This can be seen from the large number of observations preferring the corresponding level 'K' of the interaction effects (a combination of levels 'L' and 'K' of the main effects leads to level 'K' for the interaction effect). A third effect contradicts the theoretical reasoning: Level 'K' of "Cost*Relationship" is more often preferred than level 'L'. This shows that the positive effect of high cost savings does not outweigh the potential disfunctional effects of cooperating with competitors. On the contrary, the benefits of cost-savings are valued with less importance if competitors enter the cooperation. A predominance of a conservative approach towards cooperating with competitors can be stated.

From the discussion above some first conclusions can be drawn: One has to be careful to aggregate the data, because this would mix different cooperation strategies. While many respondents favor the advantages of cooperations - cost savings and specializiation - and while they prefer non-competing partners, they show conflicting preferences in regard to mission, outcome and interaction effects. Those different strategies require separate analyses.

In order to explore shared patterns in the preference structures, a **clustering** of the individual utility functions is performed. Since individual interaction effects showed to be relevant only in small subsets of the observations, the clustering performance is restricted to the main effects. Six clusters are extracted using WARD's method with squared Euclidean distance. Figure 3 shows the underlying dendrogramm. The individual clusters are sufficiently homogeneous, as only two out of 30 F-values are greater than one.

In a second step, the preference functions are reevaluated on the aggregated level of single clusters. The observations within each cluster are treated as multiple responses. First, a main-effect only model is estimated. Afterwards, interaction effects are added as long as they show to be of significant importance within the specific cluster (significance level: 5%). This procedure of including selected interaction effects on the group level has been recommended by Green and Srinivasan (1978, p. 118). The results are shown in figure 4. A listing of cluster characteristics reveals interesting tendencies about cooperation strategies:

Cluster I (10 observations) distinguishes itself from the others by its focus on the variable "strategic mission": Cooperations are pursued preferably for the enhancement of existing core technologies due to cost reasons. The reluctance against cooperating with competitors is slightly higher for projects aiming at marketable outcomes.

Cluster II is the most common type (25 observations). It can be characterized by the high relevance of potential disfunctional effects. Competitive relationships to partners constitute a decisive criteria for cooperational decisions. If projects aim at marketable results, the fear of competition becomes even larger (interaction effect AE is the third most important effect). This type of cooperating firm seeks predominantly cost advantages and to a much lesser degree complementary skills. Some preference is been given to projects in existing core technologies.

For **cluster III** (12 observations), the special emphasis lies on the benefits of cooperating - both cost advantages and specialization. Cooperations are preferably used for entering new areas of technology. Disfunctional effects of cooperating with competitors are seen as neglectible. However, the benefits of specialization are valued higher if the partners are non-competing firms (interaction effect DE).

Figure 3: Dendrogram using Ward Method

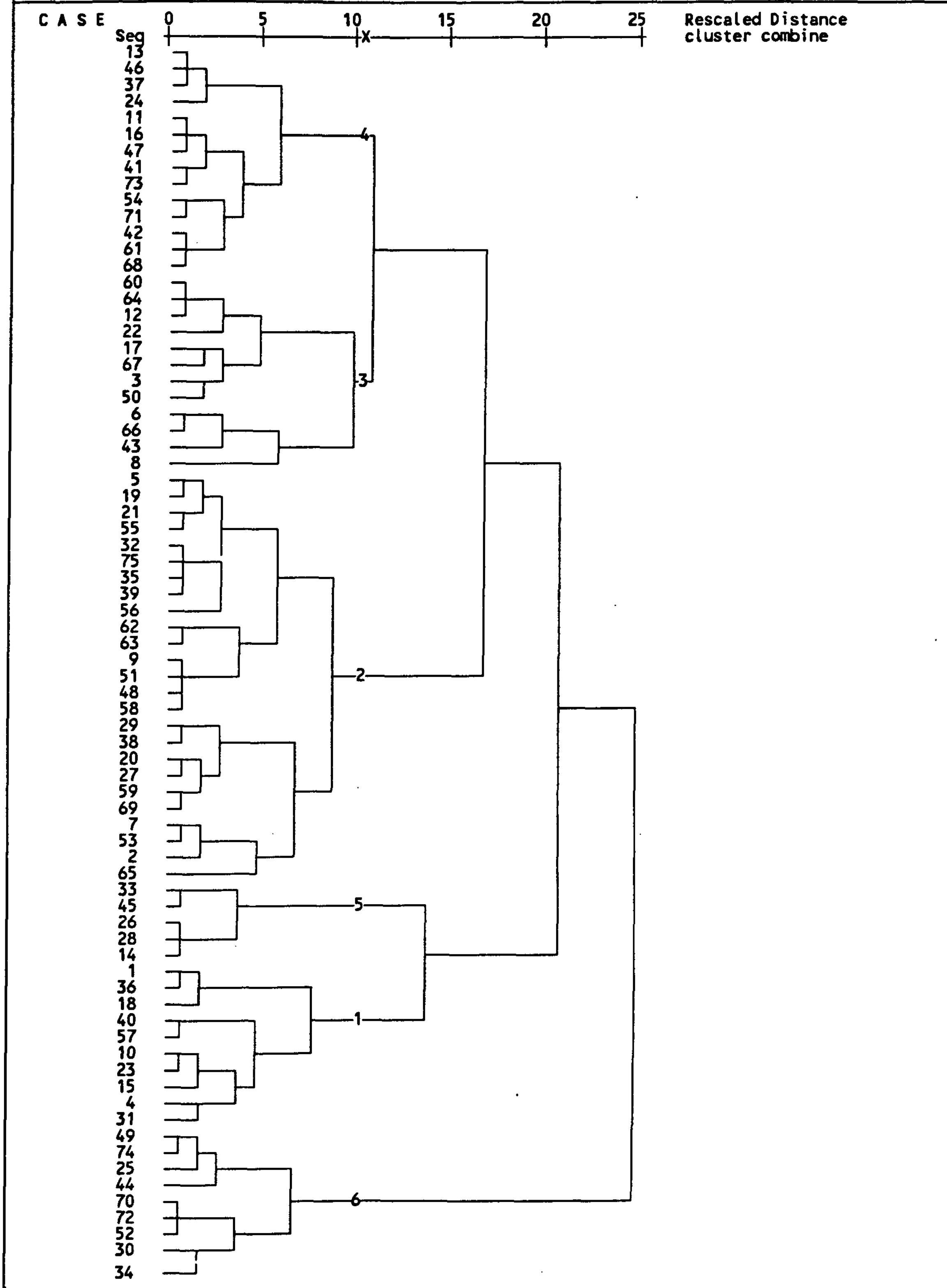
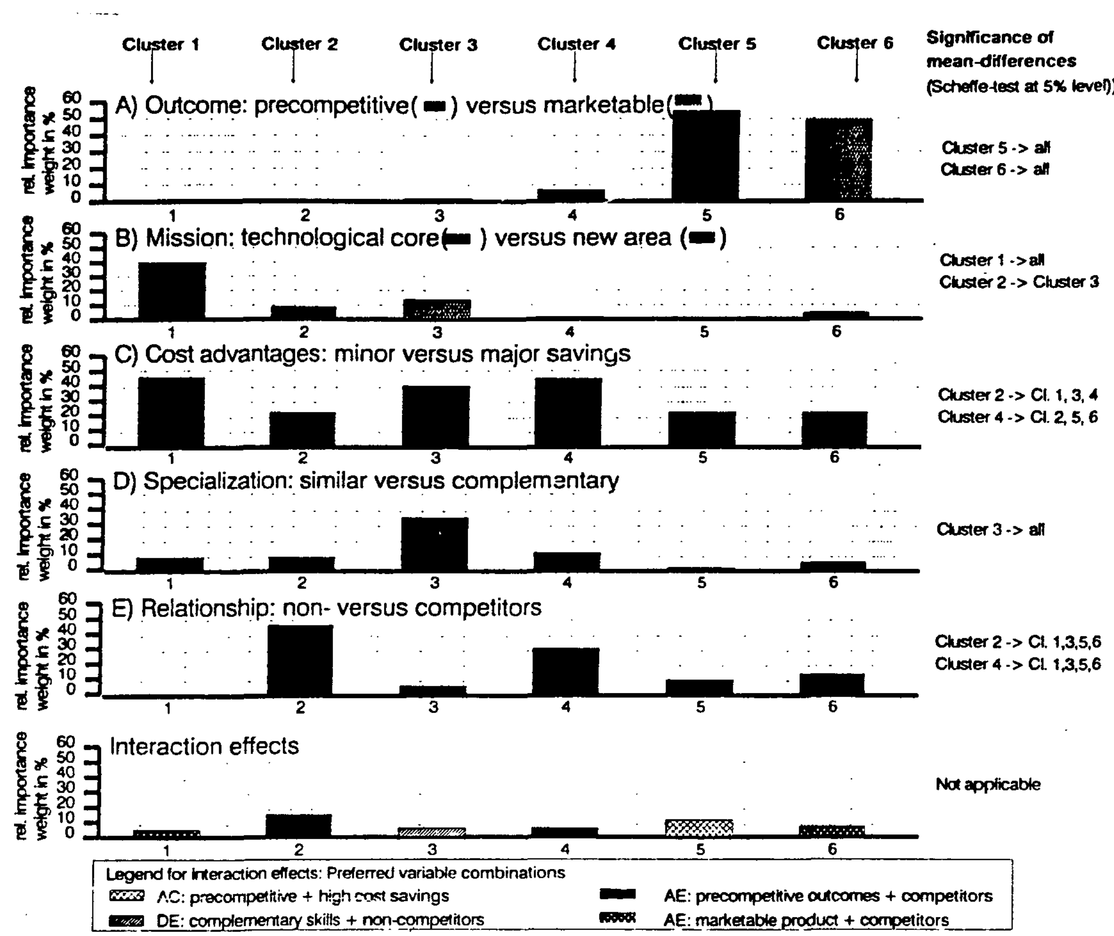


Figure 4: Utility functions of clusters (importance weights with indication of sign)



Cluster IV (14 observations) corresponds to the second cluster. However, the trade-offs between the benefit of cost saving and the potential pitfalls by cooperating with competitors are changed: Cost considerations are of predominant importance, the relationship of partners is only second-rated. Marketable outcomes are preferred to some extent in comparison to precompetitive projects, whereby some more caution is given to potential effects of competition.

Precompetitive researchers who cooperate purely out of cost considerations are found in cluster V. Those cooperating firms have only a slight aversion against competitors. While it can be assumed that this cooperator type is the classical one at least for industrial research associations, it is of minor importance in this sample (5 observations). This might be due to a preselection bias in this study, because only participants of cooperations with a predominance of industrial partners have been selected.

Finally, cluster VI (9 observations) distinguishes itself from the other clusters mainly by the high preference given to marketable outcomes. If a project aims at marketable outcomes, even cooperation with competitors is valued more favorable (interaction effect AE). The cost motive is the predominant reason for cooperating; complementarity has next to no importance. Finally, some preference is been given to the mission of entering new areas of technology.

As a first flash on the underlying dimensions of these clusters it might be stated that some of the largest companies are in cluster I. The less experienced cooperating firms are to be found in cluster II; companies within cluster III cooperate more on a national scale. Some of the most experienced cooperating firms are in cluster V.

V. Conclusions

The above findings constitute interim results only. The research project is still in progress and it will come up with further conclusions later on. However, the following conclusions can be drawn:

The following hypotheses derived from theoretical and empirical evidence are been supported by the data: R&D cooperations are as well suited for precompetitive research as for obtaining marketable results (H_A). The higher the expected cost savings, the more preferable is a cooperative project (H_C). Cooperating companies prefer partners with complementary skills and resources (H_D). Cooperations with non-competing firms are preferred (H_E).

The following hypotheses are supported only from subsets of the data: Just one cooperator-type favors projects aimed at generating new areas of competencies (H_B). For one third of all cases, cooperations with competitors are seen as less favorable if projects aim at marketable products instead of precompetitive outcomes (H_{AE}). Precompetitive oriented researchers put special emphasis on the aspect of cost savings, if the project aims for the desired precompetitive outcomes rather than for marketable products (H_{AC}).

It has also been shown that there are high variations in the perception of the importance of project characteristics. The differentiation into clusters led to the conclusion that the cooperator types base their cooperation decisions on a small sub-set of specific factors. While it is too early to come up with final conclusions, this discussion might show the advantageousness of such a comparative, simultaneous analysis.

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