Technology and Market Orientation in Company Participation in the EU Framework Programme*

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Abstract

This paper will analyse the nature of the EU Framework Programme, particularly its degree of market-orientation and precompetitiveness, at the time of the Fourth Framework Programme. The paper will show that precompetitiveness as a project or participation attribute is independent of technology or market orientation, with technology orientation meaning participation in the Framework Programme for learning and knowledge, market orientation for commercial objectives. Technology or market orientations appear almost as frequently as basic motivations for company participation in the programme. However, companies usually choose one of the two as their collaboration mode. The paper will further show that the Framework Programme participation by firms continues to be mainly precompetitive. This is due to the special circumstances and the contract principles of the Framework Programme.

Introduction

Originally, the EU Framework Programme, or rather its flagships from the Second Framework Programme onwards, the information technology programme, ESPRIT, and its parallel programme in telecommunications, RACE[1], represented programmes that were supply, that is technology-oriented. They had a mission to enhance the competitiveness of European industries by raising their technological level. The means was collaborative R&D among European information technology firms and public sector research institutes. Joint research was expected to help companies raise their technological knowhow and solve generic research problems that had wide applications across many industrial sectors. The model was originally taken from Japan where it was perceived to be successful (Peterson and Sharp, 1998). In the very beginning, the participating firms in the collaborative programmes were major competitors (see e.g. Peterson, 1991).

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[1] The ESPRIT pilot phase was approved in 1982 and the first ESPRIT Programme started in 1984. The definition phase of RACE started in 1985, and the first RACE Programme was launched as part of the Second Framework Programme in 1987. ESPRIT and RACE were integrated with the Framework Programme as of the Second Framework Programme.

Over time, there have been changes in the general objectives and in the emphasis on technology orientation. Today the Framework Programme encompasses a wide range of targets from cohesion and job creation to the contribution of the programmes to the implementation of the various Community policies (Decision No 182/1999/EC..., 1999). In the programme documents, the technology/supply orientation has given way to a greater emphasis on diffusion and demand oriented research collaboration. This means helping European companies transfer research results to marketable products and improve their business performance, thus enhancing their turnover and employment (Growth, Competitiveness, Employment, 1994; Green Paper on Innovation, 1995). The extent to which diffusion orientation has indeed happened in programme practice has been little studied.

According to the studies on the impact of the Second Framework Programme, in the early stages, knowledge-related factors, which correspond to the technology or supply orientation, motivated the participation of companies (Reger and Kuhlmann, 1995; Luukkonen, 1998). However, the extent to which the above changes in the overall policy aims have influenced the orientation of projects in terms of precompetitiveness and market orientation has not been studied. There are some recent findings indicating that firms' participation in the Framework Programme has been somewhat more motivated by commercial objectives than before (Ohler et al., 1997; Luukkonen & Hälikkä, 2000). We still do not know whether this signals a fundamental change in the orientation of the Framework Programme?

The research problem

This paper will analyse the nature of the Framework Programme, particularly its degree of market-orientation and precompetitiveness, at the time of the Fourth Framework Programme. Precompetitive research, that is research which is a few years removed from the market phase[2], was an important part of the original collaboration model of the Framework Programme. The research to be funded was expected to advance the competitiveness of European industries in general and not that of individual firms. Generic research carried out by firms and by public sector research institutes was the medium to advance this goal. This model implied that the research to be carried out was to be precompetitive. Near-market research is confidential and

[2] The first EU Science and Technology Indicators Report defines the term precompetitive as "RTD activities that private and public companies carry out together, before developing and selling their own product separately" (The European Report..., 1994). Managers' views on what constitutes precompetitive research in practice may differ and therefore this concept should be used with a caution.

advances the interests of individual firms and therefore, it could not be funded from the public purse. Given the fact that programme goals have emphasised market orientation and implementation of knowledge to economic applications, the major research question in this paper is whether this has led to near-market research at the cost of precompetitiveness.

A related question concerns the circumstances under which firms can collaborate with their competitors in EU projects, which was the starting point in the very early stages in the big information technology programmes. My previous studies of EU collaboration have shown that companies have reservations to embark upon collaborative R&D with their competitors. Firms have to solve many problems related to the extent to which background and foreground knowledge is shared, even though sharing knowledge is clear in principle. There are also fears concerning knowledge leakages, and intellectual property right issues have to be solved (Luukkonen, 2000). This paper will explore the willingness of companies to collaborate with their competitors and whether their willingness is related to the precompetitive versus near-market nature of the collaborative R&D.

The analysis of this paper is based on the underlying notion that the innovation process takes place in a complex and ever-changing environment, and therefore involves uncertainties and risks. Companies solve research and research management problems through 'trial and error', or put in another way, through 'learning' and 'experimentation' (Patel and Pavitt, 1997). In order to gain access to new knowledge they also experiment with R&D alliances with outside organisations. R&D collaborations are not a new phenomenon. However, there are indications that R&D collaboration with outside organisations, other companies and research organisations, is an increasing trend, particularly in the information and biotechnology sectors (Hagedoorn & Schakenraad, 1990). R&D collaboration has many benefits and it is seen as a positive factor for the success of the innovation process. Firms may achieve economies of scale, search for new market opportunities, accelerate the innovation process, achieve complementarities, and utilise spill-overs of R&D within the consortium (Freeman, 1991, Hagedoorn and Schakenraad, 1990; Teece, 1992; Sakakibara, 1997). Collaborative R&D also involves special costs, and this is why companies need a push to embark upon it, hence government action. Governmental programmes to promote collaborative R&D have become more prevalent since the 1980s. The EU R&D programmes emerged in the early 1980s and are an important mechanism to promote inter-organisational and inter-country R&D collaborations.

In this study, Framework projects are regarded as R&D alliances among firms and public sector research institutes (Luukkonen & Hälikkä, 2000). Formally these are fixed term alliances spanning approximately three years, though in practice, many alliances span over the project life-cycle with central partners continuing their collaboration in a new EU project or in another context (see for example, Larédo, 1995). The R&D alliances made within the EU context have been facilitated by the opportunity offered by public subsidy. The aim of the policies is to lower the threshold for such alliances and even though it is likely that this aim is achieved, it is difficult to estimate the extent. Because of the lower threshold for cross-border R&D alliances in European programmes, the findings concerning them cannot be directly compared with more 'spontaneous' cross-border R&D alliances and ventures (see e.g. Hagedorn and Schakenraad, 1990; Flordia, 1997; Kuemmerle, 1999). The motivations for such 'spontaneous' cross-border endeavours will, however, be considered in the context of the present study.

This paper will analyse the role of the EU Framework Programme for a sample of companies with business operations in Finland and which have participated in the Fourth Framework Programme for Research and Development. The paper will pay particular attention to the two basic types of orientation in companies' participation in the Framework programme: 1) technology orientation, and 2) market orientation. It will analyse whether these two types are related to the nature of research carried out in the projects, in particular, whether the projects represent the so-called precompetitive or near-market research. The analysis will also pay attention to the propensity of companies to collaborate with their competitors in EU projects.

The paper will show that precompetitiveness as a project or participation attribute is independent of technology or market orientation and that the Framework Programme participation by firms continues to be mainly precompetitive. This is due to the special circumstances and the contract principles of the Framework Programme, to be discussed in the paper. Technology or market orientations appear almost as frequently as basic motivations for company participation in the programme. However, companies usually choose one of the two as their collaboration mode.

Data

The study is mainly based on 49 interviews with 41 companies that have business operations in Finland and that have participated in the Fourth Framework Programme. The majority of the

companies have a home base in Finland, but in four cases, their headquarters were elsewhere and the company located in Finland was a foreign subsidiary. Twenty-eight of the companies were large and 13 small or medium-sized (the definition used is that valid at the time of the Fourth Framework Programme[3]). Because of the small size of the sample, particularly that of SMEs, the study is to some extent a case study. The data will be complemented with analyses from an extensive survey among Finnish participants in the Fourth Framework Programme (Luukkonen & Hälikkä, 2000).

The interviewed companies were chosen on the basis of the VTT-Tekes database on the Fourth Framework Programme[4]. The sample was not random. The companies were chosen to represent different industries and branches with a broad range of R&D intensities, and their participation was to represent different types of specific programme within the framework programme. The sample includes proportionally more firms with several project participations than on average in the original population. Even though an effort was made to choose a sufficient number of low-tech SMEs, the majority of these turned out to be very high-tech. This presumably reflects the characteristics of the original population.

In many cases there were only few companies by industry, with the lowest number being two companies by industry. Therefore, it is difficult to ascertain industry-level patterns of behaviour. However, for example, in pharmaceuticals, the two companies are the only large pharmaceutical companies Finland. In the forest sector in Finland, there are three major firms.

The interviewees from large companies were persons with a function of a technology or an R&D director, and those from the SMEs were directors of the companies. In five large companies, the R&D directors (or directors) of more than one business division or unit were interviewed, but in most cases, the interviewee was the technology or R&D director of the whole group. If several technology or R&D directors or equivalents were interviewed, their answers were analysed together to obtain the overall corporate strategy. There were two exceptions though, Fortum and Raisio Group. In the latter case, the divisions represented different industrial sectors and were therefore analysed separately. In the former case, two firms

[3] Small and medium sized enterprises employ fewer than 500 people, less than one third of their capital is in the hands of another company, unless this is another SME, a bank or a venture capital company, and their annual turnover does not exceed ECU 38 million.

[4]This database on Finnish participation in the Fourth Framework Programme was compiled by VTT Group for Technology Studies, and it includes data obtained from Cordis, the EU Commission and national delegates to the Pogramme Committees of the framework programme (see Luukkonen, Hälikkä, 2000).

had just been merged together and the interviews concerned the time when they were separate companies and were therefore treated as such. Most interviews were one-person interviews, however, in two cases, two persons were present at the interview. The interviews were semi-structured with an interview scheme and involved probing issues further depending on the situation of each firm. The interviews took place from March - December 1999. They concerned the company's participation in the Fourth Framework Programme and to some extent, their prospects for the Fifth Framework Programme.

The study also draws on a survey on the impacts of the Fourth Framework Programme in Finland, carried out in spring 1999 (Luukkonen & Hälikkä, 2000). This survey was very extensive and covered all Finnish participants in the so-called shared-cost actions in the Fourth Framework Programme.[5] The survey response rate was 72 % for large companies and 68 % for SMEs and the total number of firms that responded was 244 (146 were large and 98 small and medium-sized firms). The overall findings of this survey are reported in Luukkonen and Hälikkä, 2000. This paper will use the survey data to further analyse the interviewed firms; it also reports some findings for all the surveyed firms.

The analysis of this paper mostly concerns the firm level. Some matters are also analysed at project level. Because the interviewed firms do not constitute a random sample, statistical tests of significance have not been used. The Appendix Table gives the number of the companies and some of their characteristics.

Findings

Technology and market orientation

In this study, the distinction between technology and market orientation as a basic orientation in EU R&D collaboration was inspired by the studies by Florida (1997) and Kuemmerle (1999). They refer to this differentiation in their analyses of foreign-affiliated R&D laboratories in the US (Florida) and foreign direct R&D investments by firms (FDI) (Kuemmerle). Florida (1997) uses the terms supply- and demand- orientation to refer to technology and market orientation, Kuemmerle speaks of home-base-augmenting and home-base-exploiting FDI respectively (1999). By the former, Florida means "a strategy to maintain competitive advantage by

[5] SMT, Innovation, CRAFT and Inco programmes were en exception and were excluded from the survey (Luukkonen & Hälikkä, 2000).

generating new technological assets and capabilities" and Kuemmerle "investing in foreign R&D in order to acquire new knowledge and capabilities". By demand motivation, Florida refers to "adapting and tailoring products for foreign markets and providing technical support", while Kuemmerle speaks of "firms seeking to exploit firm-specific capabilities". In this study, the terms 'technology' or 'market' orientation are used. Technology orientation denotes participation in the EU Framework Programme in order to learn from partners, to enhance the knowledge base of the company, to train R&D personnel, to monitor the development of the field, and to maintain or create good contacts with important university or research institute partners. It largely, though not completely corresponds to knowledge-orientation, used in my survey-based impact studies of the Framework Programme (Luukkonen & Niskanen, 1998; Luukkonen & Hälikkä, 2000). Market orientation denotes participation with a motivation to develop products or processes, to gain access to new markets and to learn to act in new markets, and potentially to create business alliances for marketing purposes later on. In the before-mentioned surveys, market orientation corresponded roughly to business-oriented goals for participation.[6]

Even though this distinction is used to compare firms' R&D alliances within the EU context, it does not mean that EU projects would be expected to be comparable with direct foreign R&D investments, as studied by e.g. Kuemmerle (1999) or Florida (1997). As said above, EU R&D collaboration is facilitated by public subsidies and it is different from longer-term foreign R&D investments in many other respects, for instance, because of its time-span and being regulated by special collaboration rules. Also they do not involve R&D investments in other countries. This classification is used because it summarises two basic motivational dimensions in EU R&D participation and helps analyse the motivation to participate separately from the nature of research (near-market versus precompetitive).

Eighty-six percent of the large companies had more than one EU project each, on average 7 projects, while the corresponding proportion for SMEs was 39 %. A company with more than one project could have different motivational background for different projects as can be surmised from Table 1.

[6] In my survey-based impact studies, there are two additional goal dimensions, resource-related goals and networking goals (see e.g. Luukkonen & Hälikkä, 2000). According to a factor analysis made, the business-related goals were further divided into five subclasses, two of which corresponded to the market orientation in this study: expansion of business activities and productivity related goals (*ibid.*).

Table 1. Technology and market orientation in company participation in the Fourth Framework Programme

	Large	SMEs	Total
Technology	82 %	31 %	66 %
Market	46 %	85 %	59 %
Overlapping	28 %	16 %	25 %
	N=28	N=13	N=41

Both technology and market orientation are important for companies in their participation in the EU Framework Programme. One fourth of the companies participated with both technology and market reasons, but the majority of companies, 75%, did so for either one of the two reasons. The companies with only one project always participated with only one type of orientation. When such companies have been excluded, 60 % of the companies had chosen one of the alternative orientations. Thus over half the companies had a distinct participation strategy in their EU collaboration and either sought to enhance the knowledge and skills base for the company or attempted to improve particular products or processes, or sought new markets and business alliances.

Large firms and SMEs differed from each other in this respect. The small number of cases, particularly that of SMEs, and the skewed nature of their sample in terms of R&D intensity is, however, an important restriction for drawing generalisations. A great majority of the large companies had a technology orientation, while nearly a half also had market-orientation for some projects. A large overlap concerning orientation reflects their larger number of projects compared with that of the SMEs. In contrast to the large companies, SMEs mainly participated for market-oriented reasons. As can be seen in the appendix, the SMEs in our data were quite R&D intensive (75% as contrasted with 37% of the large companies), and as revealed by the interviews, such firms hoped EU collaboration to help the commercialisation of their new R&D intensive products. The firms have been divided into two groups according to their R&D intensity (as a percent of turnover[7]) with 4% defined as the cutting point (see Appendix Table).

Table 2. Technology and market orientation and R&D intensity of the firm

	Technology orientation	Market orientation	
High R&D	53 %	68 %	N=19

[7] One of the high-tech SMEs did not yet have any turnover.

Low R&D	80 %	45 %	N=20

Note: the R&D intensity of two firms was not known and the total number of firms in Table 2 is therefore 39.

Table 2 juxtaposes technology and market orientation with the R&D intensity of the firm. High R&D intensive firms had more often market orientation, while low R&D intensive firms were more technology-oriented in their participation. This result might seem unexpected since it is likely that low R&D intensive firms carry out more market oriented R&D and less long-term research. However, a possible explanation is the fact that their own market-related research is short-term and usually takes place with customers, it is therefore too confidential to be done in the EU context. This was particularly pointed out in my earlier interview study with technology directors of firms participating in earlier framework programmes (Luukkonen & Niskanen, 1998). The EU Framework Programme presumably provides low-tech firms with an opportunity to carry out more long-term and technology/knowledge-oriented research. The current interviews also revealed that public programmes, at the EU or at the national level, promote longer-term and more risky research projects than carried out in firms on average. Public support facilitates the decision-making by the company management to embark upon such research projects. These will not bring commercial returns in the short run and their funding requires a firm belief in returns in the future and willingness and ability to take risks. In firms that do little research themselves this matter can play an even greater role than in firms that are more accustomed to carry out longer-term research and not only developmental activities that represent near-market research.

Table 3. Precompetitiveness and technology and market orientation

	Technology	Market	Total
Precompetitive	93 %	88 %	90 %
Near market research	19 %	25 %	20 %
	N=27	N=24	N=41

In the interviews, precompetitiveness was defined as research that is far from the market phase and it was contrasted with near-market research. Overall, as many as 90 % of the companies had precompetitive projects while only 20% had near-market projects (the overlapping 10% had both). By far the greatest majority was engaged in precompetitive research projects. While there was a slight tendency for companies with market-oriented participation strategy to be

more engaged in near-market projects, the difference is not big and considering the small number of cases, the results have to be treated with caution. The finding strongly suggests that EU research collaboration is still very much in the precompetitive mode irrespective of the basic motive for participation. Large companies and SMEs did not differ decisively in their propensity to collaborate in precompetitive research projects (Table 4).

Table 4. Precompetitiveness and size of firm

	BIG	SME
Precompetitive projects	93 %	85 %
Near-market research	21 %	15 %

The prevalence of precompetitive mode can be explained by the rules governing EU research collaboration: the fact that the research findings are to be shared among all participants of a consortium makes near-market research more difficult. Such research is typically confidential and cannot be done in this kind of framework.

In spite of being precompetitive, one third of the projects had already led to commercial applications, 33%. This information is based on the survey findings on the firms interviewed, In the whole survey data the corresponding percentage was a little larger, 39 %. This result can be understood taking into account that companies often carry out in parallel more confidential and near-market research, and it can be presumed that taken together, this research can lead to some commercial utilisation early on in the project life-cycle.

Table 5. Commercial utilisation of the research findings and technology and market orientation

	Technology	Market
Has already been commercially utilised	31 %	37 %
	N=111	N=72

There is not a big difference in commercial utilisation by orientation, though as is to be expected, there is slightly more utilisation if the company has market orientation in its participation.

Collaboration with competitors

Practically all companies collaborated in consortia, which consisted of university and/or research institute participants and a variety of company participants. Twenty-two % of the interviewed firms had some projects together with their direct competitors, while 98 % of them said that they had projects in which they did not have their direct competitors as partners. The overlap had both types of cases. According to the whole survey data, in 26 % of the projects of the firms had a direct competitor as a partner, most often a foreign one, and 36% an indirect competitor (Luukkonen & Hälikkä, 2000).

If a company had both types of consortium, ones with and without competitors, the interviewees emphasised that the competitors were in the precompetitive projects, not in the near-market research projects. As reported above, it was more common to co-operate with indirect than with direct competitors on the same project. They do not represent a similar threat to confidentiality or pose as many problems in sharing intellectual property rights. Still, some companies pointed out that even in such cases they could only participate in precompetitive projects.

There was a metal industry firm that had a project which represented near-market research and that had a direct competitor as one of the partners in the project. It is an interesting question how the situation was dealt with. It turned out that in the project, there was a clear division of labour, which entailed that each competing firm was looking at a different aspect and would tell the results to each other. The firms felt that they would both gain from these arrangements and that their interests would not collide.

Interestingly, large companies collaborated more often with their direct competitors than SMEs did (Table 6). This finding holds for the whole survey data with some modifications: in the survey data, in 30 % of the projects by the large companies had direct competitors while 20% of the SMEs had these. The fact that large companies had more collaboration with their competitors could be explained by their having more technology-oriented projects, which were learning-oriented. However, this turned out not to be the explanation for their higher propensity of large companies to collaborate with their competitors. Collaboration with competitors was only weakly related to the orientation of firm in technology or market oriented R&D (see Table 7). This was an unexpected finding. It may be that large firms could find more possibilities in

collaboration with their competitors because they have larger R&D resources and can carry out parallel in-house projects and overall have a larger project portfolio.

Table 6. Collaboration with competitors and size of firm

	Competitors	
Large	29 %	N=28
SMEs	8 %	N=13
Total	22 %	N=41

Table 7. Collaboration with competitors and technology and market orientation

	Competitors	
Technology	26 %	N=27
Market	17 %	N=24
Total	22 %	N=41

Again unexpectedly, low-tech firms collaborated more often with their direct competitors than high tech firms (Table 8). The survey data reported more collaboration with competitors for both groups. This can probably be taken as a more accurate picture since the data were collected by the project.

Table 8. Collaboration with competitors and R&D intensity of the firm

Where firm collaborated with its competitors in EU project	Survey data concerning the interviewed firms; basic unit=project		Interview data; basic unit= firm	
High tech firms	26 %	(N=43)	16 %	(N=19)
Low Tech firms	40 %	(N=85)	30 %	(N=20)

On the basis of this data, we do not know the importance of links with competitors for the research projects. According to a survey of Finnish innovations from the mid 80s till the end of the 90s (Palmberg et al., 2000), 12 % of the firms told that competitors were important or very important collaborative partners for the development of the innovation. According to Arundel and Geuna (2000) in a different set of data, nearly the same percentage, 14%, of firms perceived reverse engineering, that is learning from competitors, to be an important external

information source to innovative activities. Both findings reinforce the notion that competitors are less important as a knowledge source than other types of partners, particularly those along the value chain or public research organisations. The firms in our data collaborated with their competitors less than with the other type of partners, and this indirectly confirms the above findings.

Vertical supply chains

According to available information, collaboration within the vertical supply chains and in particular, with customers, is the most important source of information in the innovation process for companies (Palmberg et al., 2000) or equally important as public research institutes (Arundel and Geuna, 2000).[8]

Research collaboration along the value chain can take place at various phases of the commercialisation process and can be far from the market phase. According to the data of the interviewed firms, obtained through the survey on Finnish firms in the Fourth Framework Programme (Luukkonen & Hälikkä, 2000), 61% of the EU projects of the interviewed firms had vertical (pure vertical and mixed) consortia. This is approximately the same as in the whole survey data, 58 %. The survey analysis elaborated the interfirm networks and in addition to the traditional types, horizontal and vertical (see e.g. Dodgson, 1994), also separated a mixed network. According to the definition used, horizontal networking involves competitors (both direct and indirect); vertical involves companies along the supply chain, and mixed networks both competitors (direct and indirect) and subcontractors or client firms. 'Other' was a leftover category that had either only one company participant or companies the relationship of which was none of those above. According to the survey data concerning the interviewed firms and their EU projects, low tech firms had somewhat more collaboration with their competitors and subsequently collaborated more in horizontal networks while high tech firms collaborated a little more in vertical networks (Table 9). The differences were, however, not large.

Table 9. Different type of networks and R&D intensity. Project level

R&D Intensity	High	Low

[8] According to the latter source, there are differences between the high, medium and low tech firms in terms of importance of different information sources: high tech firms, and to a lesser degree low tech firms, found public research as the most important source. For medium tech firms, customers in particular, and suppliers were the most important source (ibid.)

Horizontal	15 %	26 %
Vertical	27 %	23 %
Mixed	41 %	36 %
Other	17 %	15 %
	N=43	N=85

Based on survey data on the interviewed firms. Project level information.

Since vertical networks involve collaboration within the supply chain, it was assumed that in research collaboration, it would have been more commercially oriented than other network types. This was, however, not the case. The survey data showed that purely vertical networks were less commercially- or market oriented than mixed or horizontal and other consortia. This held for the whole survey data and for the interviewed firms: in the whole survey data, 26 % of the vertical versus 42 % of mixed and 33% of the other networks were commercially oriented[9]. The survey also showed that the development of technology, especially in the most rapidly developing areas such as information technology and telecommunications in particular often involved collaboration in a mixed network; it requires the co-operation of partners with varied skills and roles in the supply networks (Luukkonen & Hälikkä, 2000). Projects in this kind of areas more often than in other areas involved mixed networks. Such mixed consortia also had a higher percentage of commercial utilisation of the EU project findings than purely vertical networks, though horizontal had the highest percentage (Tables 10-11). Among the interviewed firms, commercial utilisation was on average a little lower than in the survey data.

Table 10. Commercial utilisation of EU project findings. Survey data: all firms surveyed (at project level)

Commercial utilisation	Vertical consortia	Horizontal consortia	Mixed consortia	Other	Total
Has taken place	29 %	47 %	41 %	43 %	39 %
Has not yet taken place	71 %	53 %	59 %	58 %	61 %
Total	100 %	100 %	100 %	100 %	100 %
	N=69	N=55	N=105	N=40	N=269

[9] Commercially-oriented projects were defined as ones that had the following goals as important or very important: qualitative improvements in products, product diversification, increase of productivity, new or substantially improved production processes, expansion of markets, and new business activities.

Table 11. Commercial utilisation of EU project findings. Survey data: interviewed firms (at project level)

Commercial utilisation	Vertical consortia	Horizontal consortia	Mixed consortia	Other	Total
Has taken place	17 %	41 %	38 %	34 %	33 %
Has not yet taken place	83 %	59 %	63 %	65 %	67 %
Total	100 %	100 %	100 %	100 %	100 %
	N=29	N=29	N=48	N=20	N=126

That vertical networks had a lower percentage of commercial utilisation is an unexpected finding and poses a paradox. It could reflect difficulties in conducting potentially confidential research within the EU framework. Understanding the difficulties better would require further studies.

IPR and other problems

The difficulties of collaboration in near-market research and with competitors can be understood considering the contract model of the Framework Programme. It has a general condition that all partners share the relevant information and the results obtained. This means that a company cannot require the intellectual property rights (IPR) for itself and exclude other partners. Sharing important IPR with major competitors seems very difficult and collaboration with a direct competitor is rather an exception than the rule. A notable exception is the field of telecommunications in standards-related R&D, where it is in the commercial interests of competing companies to influence the standards and have them adopted widely to create large enough markets. The special situation of the telecommunications industry will be dealt with later on.

If the partners represented companies within the supply chain, sharing knowledge and sorting IPR was not a problem. Again, there are exceptions. It was pointed out in the interviews that in the new field of multimedia, some companies did not risk participation in EU collaboration for fear that their partners might demand intellectual property rights later on in case the multimedia products turned out to be successful. It was feared that in such cases, any partner could detect possibilities to earn extra income. In another example, in some telecom projects, one or two partners representing teleoperators came to perceive that the results could be commercially exploited. Their willingness to co-operate then disappeared and they limited their contribution

to a minimum. These companies started to commercialise the results and became unwilling to provide public deliverables. It was also an IPR problem. If the companies concerned had openly admitted what they were doing, other teleoperators on the project would have demanded IPR, because the research project was carried out jointly.

EU consortia have on average seven partners (The Second S&T Indicators Report, 1997). This probably means that they are bigger than the R&D alliances companies normally have outside the EU frame. As noted before (Luukkonen, 2000), companies feel that they cannot control knowledge flows within and outside the consortium in an EU project and are afraid that sensitive information might leak through their partners to their competitors. Therefore, they cannot do confidential projects with their customers within the EU context. Companies have learned to solve these problems when they have gained more experience in EU type of cross-border R&D collaboration and have learned to select projects suitable for this collaboration framework. However, there are differences among industries and companies in the suitability of this collaboration form for their R&D activities and traditions. Tradition here refers, for example, to the way external R&D collaboration has been organised in an industry and whether there exists co-operative research establishments owned jointly and/or financed jointly by the industry. For example, forest companies have such co-operative research establishments in many countries in Europe and in the USA and Canada, financed differently in different countries. Finnish forest companies are members of many of them through their ownership of factories locally or having joined the local employer organisations. Co-operative establishments carry out horizontal, generic research for the whole industry in a country. Interestingly, research collaboration of the European Coal and Steel Community is similar in nature and the money for the projects is collected from the companies. In such arrangements, member companies have access to the research results of the institute or the programme. Some interviewees admitted that it is not easy to follow actively all the activities of such establishments. Therefore, the true degree of utilisation of the research findings of a co-operative research establishment is an open question.

A corresponding arrangement also exists in the telecom sector, where in 1991 teleoperators founded a co-operative research forum, Eurescom[10]. It entails network operators and service providers from countries within and outside the EU. The latter are currently among the pre-accession countries. Eurescom finances research projects of common interest and the results are

[10] European Institute for Research and Strategic Studies in Telecommunications

available to all member organisations/companies. They are largely related to infrastructure and standardisation questions (seamless network inter-connectivity and service inter-operability) and involve collaboration with competitors in precompetitive research questions. The budget is funded proportionally in relation to the turnover of the member companies. This organisation does not, however, compete with the EU Framework Programme because for the teleoperators, it fulfils a somewhat separate role. It concerns questions of joint interest and their mutual collaboration while EU R&D collaboration often entails R&D along vertical supply chains. By contrast, forest and metal industries companies that had participated in the horizontal and generic research collaboration as referred to above, found the EU framework difficult. In the EU framework, to some extent, they tried new collaboration forms, but found them less suitable. Their own co-operative projects were generally smaller and were carried out in the jointly owned and/or funded establishments.

In the forest sector, it was noted that participation in the framework programme through the co-operative national research centre is not easy. The three major forest companies[11] are all partners in this institute and according to its statutes, can have access to the research results of joint research, which includes EU framework projects. If the research centre participates in an EU project, all firms have access to the results. In some cases, a particular firm may prefer that the research institute participate in an EU project either alone or as a partner to the firm. If such a project is of great interest to the firm, it will face a situation in which the results will also be available to its Finnish competitors. The firms have to solve this kind of dilemmas in their participation decisions. The reasons why the firms might not want to participate themselves are many, but in addition to the above considerations, major reasons include EU bureaucracy and paper work or the availability of personnel.

In order to be able to benefit from the complementary assets of their partners in an EU project and their knowledge input, some companies reported having a parallel or several parallel projects in-house. They did the confidential part of the R&D in their in-house project and the less confidential part in the EU project. Both large and small and medium-sized companies did this, even though we might think that only large companies have sufficient resources for parallel R&D projects. Some companies even said that to exploit EU collaboration fully, a company needs in-house projects. The company can better benefit from the EU project findings and apply the results in-house even during the project's lifetime. Such an arrangement is also

[11] UPM Kymmene, Metsä Serla and Stora Enso.

an indication of the fact that the R&D concerned is important for the company, that the company is committed to the EU project and motivated to work on the issues. The existence of parallel in-house projects, which are more commercially oriented than the EU projects, is in accord with the non-linear view of the innovation process. It means that development activities in the firm give impulses to and draw upon longer-term research activities. The innovation process does not proceed sequentially in one direction (see particularly Kline, 1985, Kline/Rosenberg 1986).

Differences between industries

So far, we have looked at the findings in total for all the industries studied. In my earlier study, (Luukkonen & Niskanen, 1998), where I paid attention to the additionality of the EU Framework Programme, there were clear differences among companies from different industries. By contrast, this study did not reveal clear industry-level differences. It is to be noted though that the questions studied were different from the earlier study. According to this analysis, companies in the same industrial sector might choose different strategies and try different approaches. It was a question of different managerial strategies and choices. This is called learning or experimentation or trial and error method as mentioned earlier (see Patel and Pavitt, 1997). Additionally, companies learned from their earlier experiences and were in different stages in their learning curves in EU collaboration. Curve here means different degrees of experience and exposure. The conclusions drawn from earlier experiences and the subsequent changes in policies were not uniform.

As said before, EU R&D collaboration represents a special case in cross-border R&D alliances, and to utilise its potential, companies had to learn to deal with many types of question and particularly those related to IPR issues, as reported above. An indication of the learning process is the fact that the companies with earlier participation experiences in the framework programme had a smaller percentage of market orientation and a somewhat higher percentage of technology orientation (Tables 11-12). Those with experience would have noted that in the EU framework programme, market-related expectations are not easy to achieve.

Table 12. Market orientation by earlier participation

Participated earlier	Market-oriented	
Yes	55 %	N=20

No	62 %	N=21

Table 13. Technology orientation by earlier participation

Participated earlier	Technology-oriented	
Yes	75 %	N=20
No	57 %	N=21

Even though there were not clear patterns by industry, there were some characteristics common. One of these is that, as before (Luukkonen, 2000), the major *pharmaceutical* companies[12] were quite cautious in their EU collaboration participating only in technology- and knowledge-oriented and clearly precompetitive projects, and definitely not with their competitors. EU participation promoted technological processes of pharmaceuticals production, rather than medical-pharmaceutical knowledge and know-how. The companies found questions relating to confidentiality and IPR as important problems. According to their views, EU projects have to deal with matters that cannot be patented and this restricts the possibilities to participate. The research process in pharmaceuticals is very long and it is confidential already at the stage which can be called precompetitive. Companies collaborate a great deal with university researchers in many countries at various stages. Both pharmaceutical companies participated in EU projects because their important university partners had invited them and the EU project had an important role in the maintenance of their networks.

The small *biotechnology firms* were spin-off firms from university research and they had potential products in pharmaceutical area related to drugs, vaccines or surgical implants. The firms were about to embark upon the clinical testing phase. They had very close research collaboration relations with the universities where the research had originated and they were located in close vicinity of these universities. These firms could not think of collaboration with their competitors, which were big pharmaceutical firms, for fear of loosing their special knowledge and products to the large companies. However, they were planning alliances with large firms in order to be able to market their products in the future, in some cases also to manufacture them. They saw such future alliances to be of mutual interest and to provide the companies concerned with big sums of money.

[12]Orion and Leiras. The latter is part of Schering.

Since these firms had only been a few years in existence, they hoped EU collaboration to help construct networks, enhance their image and secure funding. As to market and technology orientation, they had a varied picture, and were not uniform in the extent of the precompetitiveness of their projects.

The *service* sector included two large and three small or medium-sized software companies and four engineering and consultant companies. Their EU participation was influenced by the nature of their business relations, which was often based on projects to customers. Where a lot of activities were customer-based, the customers as part of the overall project financed the R&D. The large software companies aimed at longer-term customer relationships by designing and maintaining whole information systems. They also had products they sold to a large number of customers. One of the engineering companies perceived that in EU projects the EU Commission was their customer. This sort of perception of the project led to a situation in which there was no partner that could have been the end user of the results.

These companies were more inclined to participate in market-oriented projects, since with one exception, all had market-oriented projects, while fewer than half had also technology-oriented projects. All the small software companies participated for market-oriented reasons in precompetitive projects, and two with no collaboration with their competitors. The rest of the companies in the service sector had both precompetitive and near-market projects. However, none of them collaborated with direct competitors in their Fourth Framework projects.

Like low R&D intensive companies in general, *steel and metal, forest and food* companies evidence more inclination to technology orientation and less inclination to market orientation than high R&D intensive companies (Appendix Table). This is not surprising, since these 14 firms are the majority of low R&D intensive companies. They were all involved in precompetitive projects and only two additionally in a near-market project. As referred to earlier, metal and steel industries as well as in forest industry have horizontal co-operative R&D arrangements at a national (forest) or at the European (steel, metal) level. These arrangements were more important for them than the EU Framework Programme, which was not easy to fit in their co-operative habits. Most companies in these industries were more or less in an early learning phases in their EU R&D collaboration and said an important motivation to participation was to learn to act in this environment.

Telecommunications presents itself as a special case, both because of its development phase and for the fact that the EU Framework Programme has played a special role in standardisation issues. It is therefore dealt with in more length than other industrial sectors.

Telecommunications

The Fourth Framework Programme was running at a time when background research for the development for and agreement on the standards for the third generation of mobile phone communications was carried out. In this situation, some of the telecommunications projects became strategically very important for the companies concerned and were related to the creation of *de facto* standards. The EU Framework Programme provided important European telecommunications companies with political support in their negotiations over standards worldwide. In such a situation, telecommunications companies were willing to collaborate with each other for their joint benefit.

An example of a strategically important project is an Acts project called Frames. It was carried out in 1995-99 and was related to the development of the standards for the third generation mobile communications technology, more precisely, according to Frames homepage, "to define a specification of a UMTS (Universal Mobile Telecommunications Systems) multiple access air interface". Frames was a very big project (around 280 person-years). Its significance was not so much in its technical achievements *per se* or in its end result (the so-called fma technique which was a combination of the tdma and cdma techniques)[13] as in the fact that major European telecommunications companies Siemens, Ericsson and Nokia collaborated towards achieving a consensus concerning the third generation standards. Frames attracted the attention of Japan's biggest telephone operator (NTT DoCoMo) and gave credibility to the European companies. These were perceived to have the political support of the European Commission in their standards development. NTT DoCoMo eventually made an agreement with Ericsson and Nokia for the development of the Japanese cdma demonstrator. The Japanese link reinforced the position of the European companies in the discussions on the worldwide standards. After many turns, which included discussions at the level of heads of state, quarrels over patent rights, and a threat of a trade war between the US and the EU, in March 1999 the meeting of

[13]Not this technique, but a cdma technique involving a compromise between the joint Ericsson's, Nokia's and Japanese as well as Siemens' technique, was eventually adopted as the European standard by the European Telecommunications Standard Institute (ETSI) in January 1998 and by the European Commission later that year.

ITU (International Telecommunication Union) adopted an umbrella standard for the third generation mobile communication worldwide, with which European companies were satisfied. This umbrella was based on cdma but enabled teleoperators to choose the particular technique they wanted.

Frames was thus a small but an important link in the process that was to lead to the adoption of a worldwide umbrella standard profitable for the European companies. The adoption of the umbrella standard was, however, just a first step. After its adoption, the race for the development of the third generation phones, networks, and the contents of the services to be transmitted through the mobile and greatly enhanced networks had only just started.

Frames may be exceptional in its subsequent influential role. It was, however, pointed out that when launching business activities in countries such as Japan and China, EU project status was perceived to lend EU support to the activities of the company/companies involved.[14]

In standardisation issues EU projects have provided a forum, often one among many, for joint negotiations between European firms over standards development. In such cases, the actual outcomes of particular projects are not as important as the role of the projects in bringing competitors together and enabling their mutual communication. In areas such as Frames, an EU project can provide an intangible benefit, presumed support and in some cases, such as that above, also formal support by the EU Commission of the technical solutions suggested by European companies.

The importance of EU support for standards development in telecommunications applies particularly to the Fourth Framework Programme. It was pointed out in interviews that the pace of change in the business was increasing and commitment to a particular technology in an EU project spanning as far as over four years was becoming impossible. The importance of such longer-term technological projects was decreasing in the industry, and overall, EU collaboration was becoming too slow with the time taken by the screening process and the decision-making delays. A way to overcome the problem of the long decision-making process was to start the project with the company's money and join the EU project when it did start.

Nokia and Ericsson had, for their Japanese interests, started to develop this technology within Frames. After the decision of ETSI, the interest of companies in Frames decreased decisively.

This was, however, possible for large firms with a lot of resources, and not for example, for universities.

Industrial alliances to develop *de facto* standards among a limited number of firms and outside the EU frame were becoming more prevalent. In such cases, a limited number of influential firms agreed on a standard and then brought the result to the public arena. Outsiders were urged to use the standard and often did so in order not to be left out of what seemed to be the forefront development.

IPR issues were regarded as vital and the companies wanted to secure patent rights. However, in telecommunications field, European firms have agreed to pool their patents and cross-licence in order to advance development in the field. They have a long history in doing so since the early days of the radio. The European Telecommunications Standard Institute (ETSI) has a rule according to which all firms that own central patents relating to a standard, are urged to give their patent to the pool at a reasonable compensation, if the standard will be accepted. Firms not owning any patents will be able to buy the licence at a reasonable cost. This rule is intended to prevent firms from exploiting the situation and charging too high a compensation for central patents regarding a standard. Formal arrangements like the one above do not exist in the USA. Still, the actual development has been fairly similar: most standards are based on agreements among several companies agreeing to pool their patents. Their intention is to develop compatible products that can be applied worldwide, and that can thus promote their business interests.

In addition to strategically important projects, EU collaboration has enabled research on questions of potential future importance, that is, research that costs so much that a single firm cannot cover all the costs. Such collaborative R&D is relatively easy to do with competitors. It was, however, pointed out that if the EU was to be of importance for the development of the field in the future, it should finance research related to longer-term developments. Such research should cover either generic topics or it should represent big industrial policy issues on which a consensus is needed (for instance, research related to the fourth or fifth generation mobile standards). It should be of potential importance in setting up future research agendas

[14] Another, quite a different role provided by the EU project status was to provide a seemingly less interested test environment for companies making usalibity trials and other near market research, which however, provided them with commercially valuable information.

and not deal with topics which are hot issues at the moment (things related to already accepted standards).

Another, quite a different case for EU collaboration were co-operative R&D projects which create business partnerships and supply chains, vertical networks. Such co-operative R&D is too close to the business interests of a company to be carried out with its competitors. The funding decisions made within the EU Framework Programme can influence such partnership chains among major European companies and thus be of industry policy importance.

Discussion

This study has shown that technology- and market-related aspects are approximately equally important motives for companies to participate in R&D alliances within the EU Framework context. Even though there is an overlap, over half of the companies choose differentiated orientation; they participate in EU Framework co-operation either to enhance the technological capabilities of the company or to develop particular products and processes and to develop the markets for their products. Large companies are more inclined to participate with a technology orientation than SMEs, which are more market oriented. It was somewhat of a surprise that high R&D intensive companies were more market-oriented while low R&D intensive companies were more technology oriented. This was explained by the fact that the EU Framework Programme provides the low-tech firms with an opportunity to carry out longer-term and more technology/knowledge-oriented research. Their own research is short-term and usually takes place with customers. It is therefore too confidential to be done in the EU context. Another reason was apparently the role of public programmes in the promotion of longer-term and more risky research projects.

The above results concerning technology or market orientation in EU collaboration cannot be directly compared with those of Florida or Kuemmerle, referred to above, since their findings relate to very different types of cases. As said, Florida (1997) analysed foreign-affiliated R&D laboratories in the USA and Kuemmerle (1999) foreign direct investment in R&D by a sample of multinational firms. Florida noted that while both types of orientation were important for the R&D laboratories surveyed, those related to the technology oriented motives were mentioned as very important more often than those related to the market-oriented motives (*ibid.*). Kuemmerle also noted the importance of both motives in the establishment of R&D facilities

abroad, but there was a clear differentiation in the orientation of particular institutions while the market-oriented institutions represented somewhat more than half of the total (*ibid.*). These studies concerned longer-term engagements than just project-based alliances, as is the case with EU collaboration. They were also carried out in order to provide evidence about the motives of companies to invest in R&D across borders (see for example, the special issue of Research Policy, vol. 28. Nos 2-3, 1999). However, at a general level, the findings of the study on the EU Framework Programme coincide with those of Florida and Kuemmerle. This study confirms the importance of both technology and market orientation as motivations for cross-border R&D. It can be claimed that to some extent all three cases represent a special case. The EU case represents alliances of shorter duration with special conditions and rules concerning collaboration. Compared with other shorter-term alliances, it might represent a much higher-percentage of technology-oriented collaboration. However, we do not have more directly comparable data of short-term R&D alliances of firms, which have not been publicly subsidised.

This study has shown that the precompetitiveness as a project or participation attribute is independent of technology or market orientation and that the Framework Programme participation by firms continues to be mainly precompetitive. Since such a great majority of the interviewees said that their projects were precompetitive, we can assume that there has not been a great change in this respect over time. The fact that the Framework Programme continues to be precompetitive is due to the special circumstances and the contract principles of the Framework Programme, discussed in the paper. Important research policy implications follow from the conclusion that precompetitiveness and market orientation are different matters in participation in the EU Framework Programme.

The study has shown that the EU type of R&D co-operation has most value for companies when it is precompetitive. Doing near-market research in an EU project seems very difficult in practice because of reasons related to confidentiality, IPR and related issues. The slowness of the decision-making process on the funding of the projects may also be more irksome for near-market research. In addition, near-market research is practically contradictory to the basic principles of EU collaboration, which presume some degree of openness and sharing information. To carry out confidential research within the EU frame, we would need a change in the contract rules concerning the Framework projects. Nevertheless, it is questionable

whether such confidential research by a company should be funded from the public purse, European or national.

In spite of the fact that the large majority of EU R&D collaboration involves precompetitive projects, around third of the companies reported commercial utilisation of the results quite soon after the project or even during its lifetime. The explanation for this potential conflict is the possibility of firms to carry out parallel projects internally, in which they utilise the findings obtained in the EU project, as expressed by one of the interviewees:

> "It [EU research] is not a suitable forum for business activities. Exploitation is usually indirect and may be based on the parallel work done in the company. The essential result is the production of intangibles, knowhow and learning that can make a commercial product. It is a misconceived idea that the projects would produce something that will directly be commercialised".

The EU Framework Programme has a special role as a frame for making co-operative R&D alliances. It provides rules, which facilitate the making of contracts and the companies do not need to start negotiating over IPR every time. These rules (patent rules, IPR rules) also limit the applicability of the EU FP to certain types of R&D.

The Framework Programme can have an important role in issues that have great industrial policy importance such as standards in telecom. Nevertheless, as pointed out, development in the telecom industry has become so fast that the EU frame may have become too slow. It may still have a potentially important role in the promotion of very long-term issues, such as in the creation of consensus on the future standards. The framework Programme has another important role as a catalyst in network building. Its additionality is difficult to study and establish accurately. However, one conclusion on the basis of the current study and many earlier studies (see, e.g, Guy et al., 1999) is its role in providing opportunities for doing things differently, in larger networks, with European partners that have special expertise in the issues studied. Limited personnel resources in firms guarantee that companies have to consider carefully the projects in which they engage themselves and is a disincentive for them to embark upon projects without clear motives, whether they are publicly-subsidised or not.

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Appendix. The Interviewed Firms

FIRM	Branch	Size*	Classification into high and low R&D intensity**	R&D units abroad	Nr of projects in FP4***	Headquarters
BioTie Therapies Oy	Chemicals, chemical products	SME	high	no	1	Finland
Finnish Immunotechnology	Chemicals, chemical products	SME	high	no	2	Finland
Multimedica	Information and communication technologies	SME	high	no	1	Finland
Picopak	Electrical machinery, electronics	SME	high	no	1	abroad
CT-laastit	Construction industry	SME	high	no	1	Finland
Leiras	Chemicals, chemical products	BIG	high	yes	1	Finland
Orion Group	Chemicals, chemical products	BIG	high	yes	4	Finland
Oy L M Ericsson Ab	Information and communication technologies	BIG	high	yes	2	abroad
Bionx Implants Oy	Chemicals, chemical products	SME	high	no	1	Finland
Renova Oy	Services	SME	high	no	6	Finland
Datex-Ohmeda	Electrical machinery, electronics	BIG	high	yes	1	Finland
ICL	Information and communication technologies	BIG	high	yes	5	abroad
Nokia Group	Information and communication technologies	BIG	high	yes	35	Finland
Medici Data	Information and communication technologies	SME	high	no	2	Finland
ABB	Electrical machinery, electronics	BIG	high	yes	10	abroad
CCC Companies	Information and communication technologies	SME	high	no	7	Finland
Energia-Ekono	Services	BIG	high	no	14	Finland
Valmet (Metso)	Metal	BIG	high	no	8	Finland
Wärtsilä NSD	Metal	BIG	high	yes	4	Finland
Insinööritoimisto Enmac Oy	Services	SME	low	no	2	Finland
Sonera Oyj	Information and communication technologies	BIG	low	yes	14	Finland
Ahlström Machinery Group	Metal	BIG	low	yes	9	Finland
Raisio Group, Chemicals Division	Chemicals, chemical products	BIG	low	yes	2	Finland
Kemijoki Oy	Energy	BIG	low	no	3	Finland
Kemira Oyj	Chemicals, chemical products	BIG	low	yes	7	Finland
Ab Rani Plast Oy	Chemicals, chemical products	SME	low	no	2	Finland
Fortum Power & Heat	Energy	BIG	low	no	23	Finland
Helsingin Puhelin Oyj (Elisa Communications Oyj)	Information and communication technologies	BIG	low	yes	11	Finland
Lekopa Oy	Metal	SME	low	no	1	Finland
Outokumpu Oyj	Metal	BIG	low	yes	6	Finland
Raisio Group, Margarine Division	Food industries	BIG	low	no	1	Finland

FIRM	Branch	Size*	Classification into high and low R&D intensity**	R&D units abroad	Nr of projects in FP4**	Headquarters
Fortum Oil & Gas	Chemicals, chemical products	BIG	low	no	16	Finland
Rautaruukki	Metal	BIG	low	no	9	Finland
Valio Oy	Food industries	BIG	low	no	5	Finland
Stora Enso	Forest industries	BIG	low	yes	3	Finland
Kvaerner Masa-Yards	Metal	BIG	low	yes	4	Finland
Metsä-Serla Oyj	Forest industries	BIG	low	yes	2	Finland
UPM-Kymmene	Forest industries	BIG	low	yes	8	Finland
Viatek Oy	Services	BIG	low	no	10	Finland
Kiteen Pontikka	Food industries	SME	-	no	1	Finland
Tieto Enator	Information and communication technologies	BIG	-	yes	5	Finland

*The classification used was valid at the time of the Fourth Framework Programme: small and medium sized enterprises employ fewer than 500 people, less than one third of their capital is in the hands of another company, unless this is another SME, a bank or a venture capital company, and their annual turnover does not exceed ECU 38 million.
**4% was the cutting point of high- vs. low-tech companies with 4% being included in the high tech group.
***Situation in summer 1998, after which nearly 40 % additional projects started.